Popular Science Monthly

239 Fourth Ave., New York

Vol. 88
No. 6

June, 1916

$1.50
Annually

Undersea Fighting of the Future

I.—Mobilizing Submarines on Rails

By Simon Lake

Under the general title "Undersea Fighting of the Future," we publish two articles, by two distinguished engineers, in which the possibilities of the submarine are set forth in a way which shows that we have only begun to learn the use of the most powerful naval weapon thus far developed. Mr. Lake's article deals with the mobilization of submarines for defense; Mr. Chandler's with a highly ingenious method of engaging and destroying submarines under water.

Simon Lake came prominently before the public notice about fifteen years ago as the inventor of a submarine on wheels—a craft which could not only navigate under water but which could also travel on the bottom of a waterway. He acted as advisor on submarines to the German and Russian governments.—EDITOR.

I FIRMLY believe the destiny of the submarine is to stop all future maritime wars between countries. A tremendous power for destruction, the submarine is in itself useless for purposes of invasion. The moment the submarine becomes visible it becomes vulnerable. Its function, therefore, is to lie in wait and attack unawares. All students of warfare must now admit that it is manifestly impossible to send an army across the sea with big guns and troops and to land them, if submarines are on watch. I believe all engineering experts must also admit that when the proper motive power for submarines is evolved, a motive power which will give the submarine the speed of a surface ship, then merchantmen cannot carry on commerce on the high seas except by mutual agreement equitable to all nations. And I believe this will hasten the day when each country will consent to agreements to "do unto others as they would be done by."

Simon Lake, the author of the article on this page, is the inventor of the "even-keel submergence type" of under-water craft which has in recent years been introduced by most of the navies of the world

If, in time of national differences, it were possible for each country to encircle itself with a zone ten miles in width, to pass which would be sure death, it would not be long before quarreling countries would make up their differences. If our country had sufficient submarines to protect its coast line and to establish such a similar zone, an offensive war would be rendered unnecessary.

Last year Congress made an appropriation calling for 25-knot submarines, to cost not more than $1,500,000 each. I saw this reported in the newspapers and I immediately wired the Department that it was impossible to secure 25-knot boats for less than about two-and-a-quarter million dollars each, and I later advised that it would then probably take several years to develop a suitable engine. The largest submarine engine of which I know is one of 1300 horsepower, completed in Italy for one of the large German boats just at the beginning of the war.

As it would probably require about 10,000 horsepower to attain twenty-five knots, Congress hardly realized how stupendous was the problem of producing at a single step a boat capable of traveling nearly twice as fast as the best underwater vessel of the day. No wonder there were no bidders for a 25-knot boat.

While it was impossible, even with unlimited money, in the present condition of internal combustion engineering, to develop a 25-knot submarine boat quickly, it is possible to get quickly a large number of 50-knot submarine boats of small size, which for the same expenditure would prove many times more effective in warding off an attack than the larger boats. I refer to what I call "amphibious submarines;" that is, submarines of about two hundred tons displacement, which could be hauled on special railway trucks from one point of the country to another at a speed of fifty knots per hour, with crews, stores, equipment, all on board. The railway tracks would be continued down under the water as a submarine railway at such points as the Government might desire. It would be necessary only to back the truck and submarine down into the water until the submarine floated. Her commander would only need to give the bell and she would be off. Such boats could probably be built for three hundred thousand dollars each to make ten knots on the surface and about eight submerged. It would be possible to get six or eight such boats for the cost of one twenty-five-knot boat and cover six to eight times as much territory. A torpedo fired from a small, inexpensive boat is just as effective as one fired from a large, expensive boat. The small boats could make the trip from New York to San Francisco in four days, New York to Boston in five hours, New York to New Orleans in thirty-six hours, in perfect safety, while a modern large submarine, under war conditions, could probably not make the trip at all, except as a slow-going surface boat, liable to capture or destruction. One hundred of these amphibious submarines could be quickly turned out by the various shipyards throughout the country, and it would also be possible to get engines quickly for them; the power required permits of using sizes of engines that have already been developed by several concerns. Such a system of coast protection would enable the quick mobilization of a large number of submarines at any threatened locality, for harbor or coast defense purposes. Of course it would be advisable to have a large number of submarines for off-shore work or to patrol the coast where distances between ports or harbors would be too great for the smaller craft.

Many disadvantages accompany the use of the storage battery. It is very heavy for the horsepower energy it carries. It is also bulky, so that only sufficient energy may be carried to propel modern submarines at about eleven knots per hour for one hour, about eight knots per hour for three hours, or at about five knots per hour for twenty hours. This means that when the energy is exhausted the submarine must ascend to the surface or secure surface connection in order to obtain air to enable her engine to be run to recharge her batteries. This is likely to prove her undoing, as the noise of her internal cumbustion engines in charging, can, with a proper receiver, be heard many miles, and would direct an enemy surface boat or submarine to her. Therefore, before the submarine can become invulnerable, she must become capable of operating without sound. If it were possible to produce some sort of primary battery whereby energy-producing material could be put into the battery like coal into a furnace, it would be ideal for submarine torpedo-boat use, and the submarine would then become invincible.

Undersea Fighting of the Future

II.—Battling with Telephones

By Edward F. Chandler

The author of this article has conducted extensive researches in the art of submarine radio transmission, applying the results to defensive and offensive means of warfare. The system of submarine navigation described in this article is the result of conclusive tests.—EDITOR.

IF the war has taught us anything it has taught us that the submarine must be reckoned with both as an annihilator of battleships and as a destroyer of commerce. Of the dozens of instrumentalities invented for killing on a wholesale scale it is the most terrible. And yet how crude is this new weapon! Compared with what it can be made it is what the blunderbuss of old is to the modern rifle.

Consider for a moment how a submarine boat is handled. The commander plows along at the surface much as he would on any ship. In the offing he sees a pillar of smoke. Friend or foe? He must investigate. Changing his course, he steers for that cloud on the horizon. In fifteen minutes he has approached near enough to discover that the smoke is pouring from the funnels of a hostile collier. She flies the naval ensign of her country, and she is convoyed by a torpedo-boat destroyer. The submarine commander gives an order. Water surges into tanks in the submarine's hold. The craft sinks until only her periscope projects from the water. Heading for the collier the submarine arrives within half a mile of its prey. The commander takes the bearings of the collier by compass and orders complete submergence. In another minute the craft is completely under the surface. A sharp command, and a puff of compressed air starts a torpedo from one of the launching-tubes. In less than a minute it has reached the collier. There is a dull explosion. Fifteen minutes later a cargo of four thousand tons of coal lies at the bottom of the sea, and a hundred brave men have perished miserably.

Edward F. Chandler, whose most important work thus far probably is the development of a submarine range-finding system and its application to the detection and destruction of hostile submarines

Why the Submarine Is Crude

It seems very simple, very certain, this torpedoing of a ship from a safe place under the water. But for all that it is unscientific and haphazard. The submarine commander sees nothing below the surface; that is why he must take aim before he submerges. To strike, the target must be large and very near; otherwise he would surely miss. Suppose that you were told to shoot blindfolded at a mark one hundred yards away and that you were given two minutes to locate the target before your eyes were covered. You would be exactly in the position of a submarine commander about to torpedo a hostile ship. Is it any wonder that torpedoes must be fired at close range? Is it not obvious that the submarine could be made still more terrible if the submarine commander could locate his quarry accurately in the inky blackness in which he is immersed?

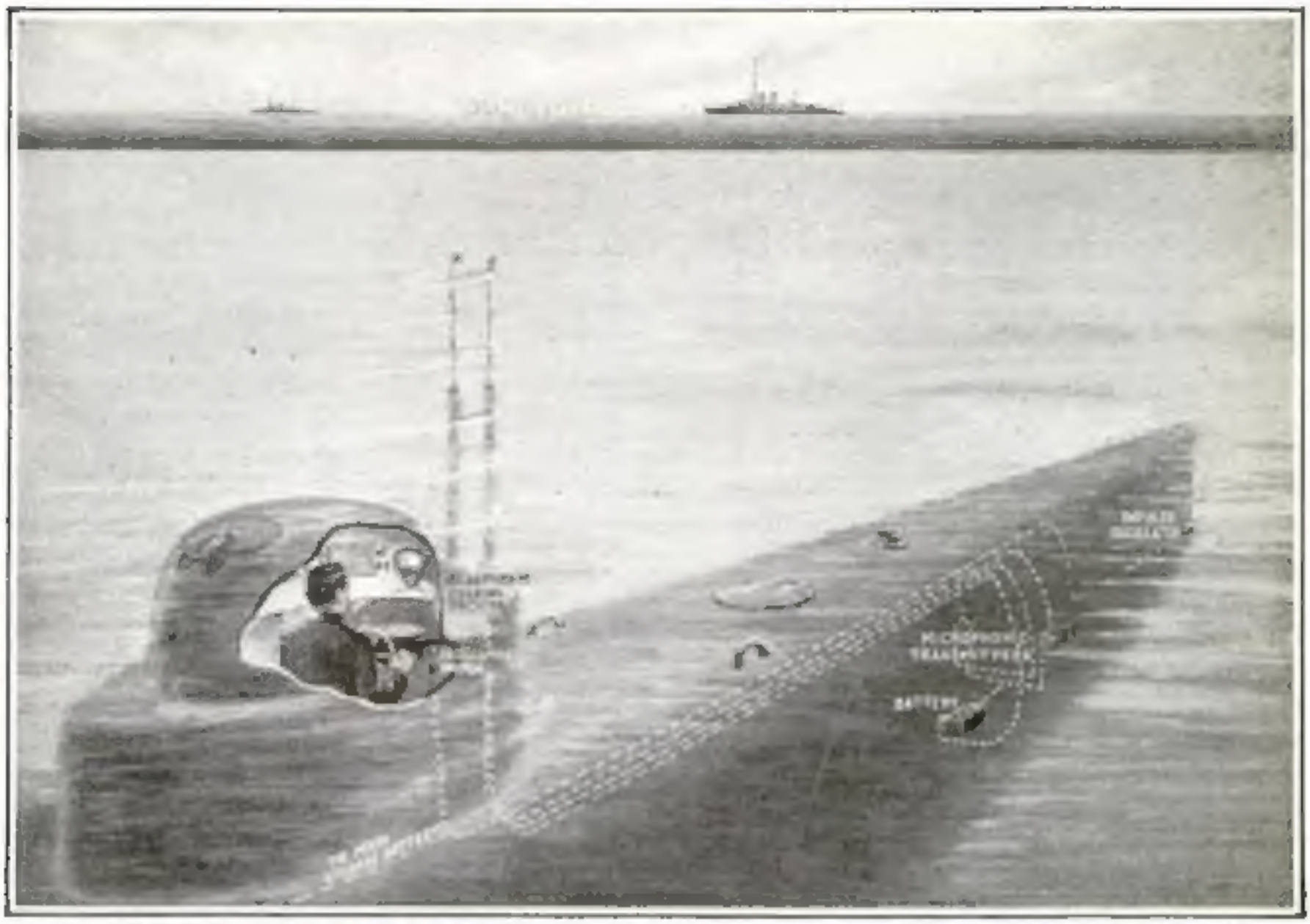
To use lights under water is hopeless. Even millions of candlepower would not reveal the presence of a ship a mile off to a submerged underwater craft. But suppose that the commander of a sub-

Although the submarine is blind after it dives it can be made to hear with the aid of microphones. If two hostile submarines were equipped so that they could hear each other there is no reason why they should not fight under water. Torpedoes would be the weapons used—torpedoes directed solely by the sound emanating from the craft to be destroyed

marine could locate his prey by sound; suppose that he could hear a ship and locate her by sound more accurately, for example, than a blind man can locate the position of a ticking clock in a room? Might not that solve the problem?

With this thought in mind, I have worked out a method of utilizing microphones—a method which is a modification and extension of that which I described in the POPULAR SCIENCE MONTHLY for October, 1915. Those who read that article will remember that I showed how it was possible to make a torpedo guide itself toward the beating propellers of a ship with the aid of microphones—"electrical ears," as I call them. A microphone is found in every telephone transmitter. It is an instrument for intensifying feeble sounds, or for transmitting sounds, and it is based on the principle that the transition between loosely joined electric conductors decreases in proportion as they are pressed together. The conductors form part of a circuit through which a current is passing, and the variations in pressure due to sound waves in the vicinity of the conductors produce variations of resistance, and hence fluctuations of the current, so that the sounds are reproduced in a telephone receiver. In the modern telephone the transmitter is essentially a microphone, the pressure of the sound waves being communicated to the conductors by means of a diaphragm.

In a torpedo of the type I described in the POPULAR SCIENCE MONTHLY, the microphones are mounted in pairs on both sides of the nose. So long as the sound of the hostile ship's beating propellers, traveling through water far more readily than sounds travel through air, affect all microphones with equal intensity, the torpedo rushes on straight to its mark. But if the vessel should change its course, the vibrations of the propellers would no longer strike the two pairs of microphones with equal force; one pair would be more affected than the other—the pair directly ex-



In order that a submerged submarine may direct its course accurately toward a hostile ship it may be provided with microphones on its port and starboard bows. The difference in the volume of sound received by the two microphones indicates the course to be pursued. The sound can be converted into movements of a finger playing over a dial

posed to the vibrations. At once electrical circuits are closed and automatic mechanism started which swings the rudders of the torpedo and points the nose of the torpedo toward its mark. As soon as the microphones on both sides are restored to electrical equilibrium, in other words as soon as they hear with equal clearness, the torpedo keeps on a straightaway course.

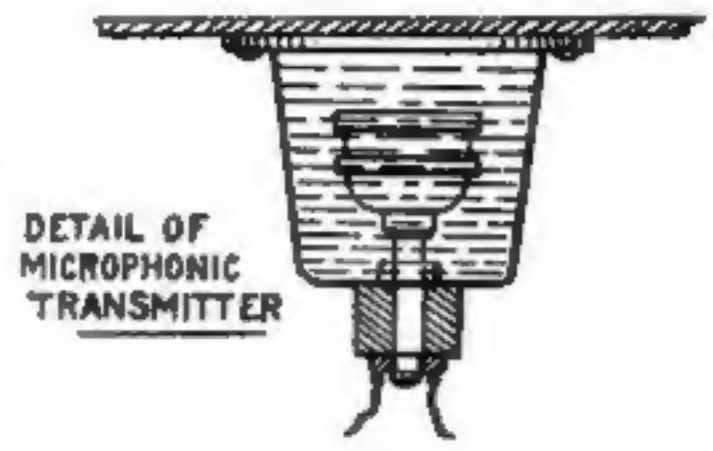
It is evident that the same principle can be applied to submarine boats traveling under water, with the difference that since the submarine is manned by intelligent human beings, the microphones can be made merely to indicate the course to be pursued, leaving to the commander the task of steering a true course. As in the case of the sound-controlled torpedo, the submarine is provided with microphones on its port and starboard bows. Telephone ear-pieces are provided which enable the submarine commander to listen to the sounds gathered by the microphones. If the submarine is not pointed head on toward the ship to be destroyed the microphone on the off side will hear less than the other, and the difference in the volume of sound received by the two microphone detectors will be noted at once in the telephone receivers. The commander changes his course until he hears equally well with both ear-pieces.

Seeing Sounds on a Dial

While it is perfectly feasible to direct a submarine by telephone it is much more effective to convert the microphone vibrations into visual signals. As a result the commander of a submarine has only to watch a finger move over a dial in order to know what course he should steer. In a sense he sees the sound which the microphone detectors hear. The accompanying diagram sets forth the essential principles of this conversion of the microphone vibrations into visual signals so clearly that an extended description seems hardly necessary.

While a visual steering indicator is

primarily depended upon to guide the submarine on its deadly errand, telephones are connected with the microphones, to be used when the occasion arises. With their aid the commander learns a new language. He realizes the meaning of strange grindings, hums, moans, blows, murmurs and vibrations—the many tongues of the sea. If we but knew it the water of the ocean is a veritable Babel; it is a great reservoir of sound, the recipient of ten thousand different vibrations, ranging from the grinding of pebbles to the pounding of steamship engines. Just as a woodsman learns the meaning of the weird soughing of wind in tree tops, the "woof" of a bear, the patter of deer's feet and the call of quail, so a submarine commander can distinguish one underwater sound from another and interpret it correctly. A tramp steamer can be microphonically distinguished from a *Mauretania*, a torpedo-boat from a superdreadnought, and above all a subsurface craft from a surface craft. Thus the character of an unseen ship miles away can be ascertained.



A diagram showing the Chandler system of converting sounds heard through a microphone into visible signals

But apart from listening to passing ships, the telephones will be required to receive messages from an admiral on a battleship five miles away. Both warships and merchantmen are equipped with submarine signaling devices—devices which send forth either bell sounds or rhythmic vibrations. It is easy to see how useful they can be made to telegraph orders to a submarine under water five miles or more away.

Under Water Echoes and How They Are Applied

In the foregoing account of my invention I have assumed that the vessel to be attacked with the aid of the microphonic steering-indicator is in motion—that its engines are giving audible sounds and that its propellers are churning up water noisily. But suppose the vessel to be attacked is at anchor—what then? Is not the submarine commander helpless?

The difficulty is easily overcome if we can make the submarine produce a characteristic sound and if we can have that sound echoed back from the ship to be sunk and picked up by the submarine's own microphones. Fortunately Professor Fessenden has provided an instrument ideally suited for the purpose. Called an oscillator, it may be regarded as a kind of underwater klaxon horn, the diaphragm of which is electrically vibrated to emit a characteristic bleat. By means of a switch, located near the hand of the submarine commander, the oscillator can be turned on or off.

The oscillator will be of use not only to locate a ship at rest but to save the submarine in a nerve-racking emergency. Imagine the commander of a U-boat bent on the destruction of a ship entering a harbor and traveling along at the surface with only his periscope exposed. A fast armed motorboat looms up—a type of craft which has proved to be a most formidable enemy. The submarine must act quickly. There is but one course—to sink quickly. Valves are opened and tanks filled. The craft

sinks out of sight. It is safe for the moment. The agonizing uncertainty of the crew can be imagined. They know that a relentless enemy awaits them, that his searchlights sweep the water all night. Hour after hour drifts by. If the submarine's commander rises, a hail of shot and shell is sure to rain upon him; if he stays under water very long he and his men will die of suffocation. Why not move on? The waiting motor-boat cannot see him. But in what direction and how far? He is almost sure to run into the shore and to puncture the thin shell that saves him from inundation. If he could only locate the harbor entrance he would be safe. An oscillator and a set of microphones will enable him to head for the inlet as surely as if he were traveling on the surface and he could see it with his eyes. He pulls the switch of the oscillator. A shrill note is sent through the water. His eyes on the steering indicator dial, he watches the response of the finger to an echo. The echo of what? Of the oscillator's vibrations reflected by the shore. He steers this way, now that way, barely crawling along, always watching for the echo on the dial. The finger on the steering indicator moves from side to side as the microphones pick up the echoes. At last there comes a moment when the finger stays at zero, when, in other words, there is no echo for the microphones to hear. That can mean only one thing: the oscillator is sending out its bleat not toward an echoing shore, but toward the harbor's mouth and toward the open sea, where safety lies. With his eye on the steering indicator the commander signals "full speed ahead," knowing that salvation lies before him.

Artificial Senses Take the Place of Eyes and Ears

The use of microphones on submarines not only increases the effectiveness of the submarine enormously, but opens up new and intensely dramatic possibilities. As soon as one submarine is equipped with devices for threading a course underwater with certainty all submarines will be similarly equipped. Grant that and at once we have the means of pitting submarine against submarine, of actually engaging in submarine fights. What strange encounters they will be—these underwater engagements of the future! Two vessels, blind but for steering indicators connected with microphones, circling around each other in the effort to ram or to plant a torpedo at the right moment, cocking electrical ears, as it were, and maneuvering entirely by sound—what battle of Wells or of Verne's can compare with it? Instruments, artificial senses, take the place of Nature's eyes and ears; hidden movements are electrically translated into twitches of a quivering finger on a graduated dial; one intelligence is pitted against another. Surely this is real scientific warfare—this battle of microphones!

A Sewer Banquet at $25 a Plate

TO celebrate the completion of a new sewer in St. Louis a cabaret banquet was held in the tube. A "banquet room" three hundred feet long and a gas-equipped kitchen were created. The food was cooked in the tunnel and served on twelve tables placed lengthwise.

The cost of the banquet was twenty-five dollars a plate.

The underground kitchen in which the meal for a banquet given in St. Louis' new sewer was cooked

Hanging a Defective Boiler Plug as a Warning

A MINIATURE gallows from which hangs a defective fusible plug responsible for a boiler explosion which occurred on board the steamship Jefferson, near Norfolk, Va., on May 11, 1914, is one of the interesting curios on the walls of the office of Secretary Redfield, of the Department of Commerce in Washington. It is a grim reminder of a tragedy which cost the lives of eleven men. A small placard above it reads:

"A Murderer! Hung for killing eleven men."

Below it are the words:

"The fusible (?) plug which failed to fuse. From the boiler of the S. S. Jefferson. Boiler exploded. Eleven lives lost."

The plug consisted of a threaded brass bushing about an inch and a half in diameter, with hexagonal head. Through the center of the bushing runs a plug of fusible metal, which, in this instance, was defective; it did not blow out when the water in the boiler became low, thereby causing a disastrous explosion. When the plug was sawed open lengthwise it was found that most of the original filling had disappeared, only a few traces of it remaining embedded in a dirty, greenish-white mass of tin oxide, which would not melt until heated to a temperature somewhat higher than 2,900 degrees Fahrenheit.

Impurities in the fusible metal, which were the cause of its failure to blow out, are easily discernible. In subsequent investigations made by the United States Bureau of Standards ten hundred and fifty fusible plugs were examined. These were from one hundred and five different makers, and about one hundred of them had been in actual use for from four to twelve months. From a study of these plugs the Bureau recommends that the fusible metal itself should preferably be pure tin, because it has been found to be far more reliable and durable. The Bureau further recommends that the tin be as free as possible from zinc and lead.

Impurities of the fusible filling of this plug prevented its blowing out and resulted in the loss of eleven lives. So, the plug was hanged as a murderer, in a government bureau

One of the many types of deterioration of fusible plug fillings observed by the Bureau consists in the formation of a network of minute thread-like cracks or corrosion-regions, ramifying in all directions. The Bureau found that these penetrated the metal and then broadened out until the filling was largely, or wholly, oxidized and destroyed. The presence of small quantities of zinc in the tin was the main contributing cause of the network type of corrosion. This was proved conclusively by the investigation conducted after the disaster.

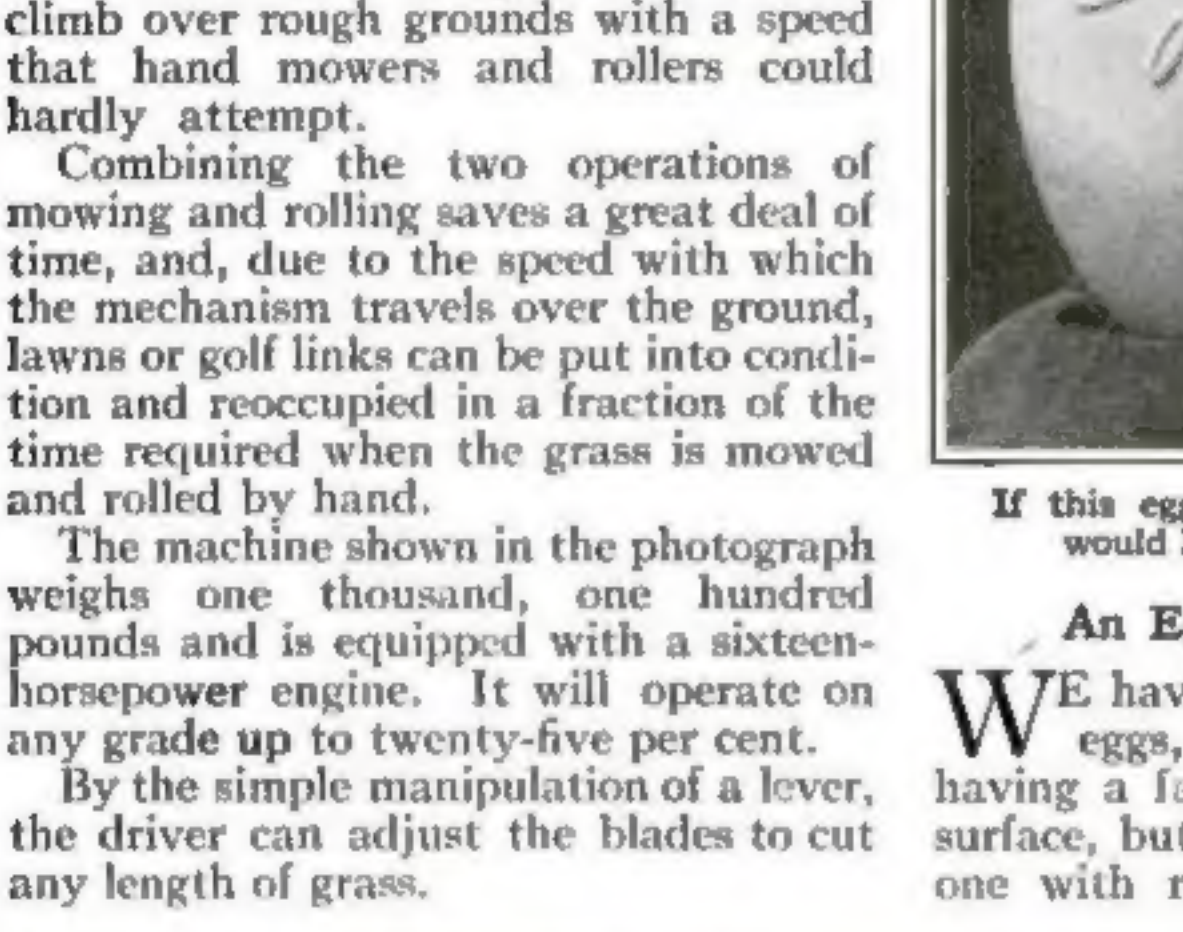
An Ingenious Combined Lawn-Mower and Roller

FOR smoothing golf links and other large tracts of land that require constant trimming, a combination lawn-mower and roller has been invented. The driving apparatus consists of a two-cylinder gasoline motor mounted on a platform in front of the driver and cooled by a rapidly rotating electric fan and water system. The machine is both broad and rather long, so that it can climb over rough grounds with a speed that hand mowers and rollers could hardly attempt.

Combining the two operations of mowing and rolling saves a great deal of time, and, due to the speed with which the mechanism travels over the ground, lawns or golf links can be put into condition and reoccupied in a fraction of the time required when the grass is mowed and rolled by hand.

The machine shown in the photograph weighs one thousand, one hundred pounds and is equipped with a sixteen-horsepower engine. It will operate on any grade up to twenty-five per cent.

By the simple manipulation of a lever, the driver can adjust the blades to cut any length of grass.



This lawn-mower and roller combined is able to smooth out the wrinkles and trim the grass on golf links in half the time usually required for such work

If this egg were a watch-dial, an hour would have only fifty-five minutes

An Egg With Hour Ridges

WE have heard of all sorts of freak eggs, from double ones to those having a few sporadic bumps on their surface, but never before have we seen one with ridges corresponding to the numerals on a clock dial. All that are needed are the hour and minute hands. There would be one difference, however, between using this egg-dial and that of a regular clock: it would register thirteen o'clock.

Freezing Cocoanuts to Get at the Milk

A PENNSYLVANIA man has devised a means of removing cocoanut shells by freezing the nut until the shell is slightly contracted, and then subjecting it to a comparatively high temperature so as to cause rapid expansion. Cracks in the shell are thus produced. A series of hammer blows then completes the breaking of the shell.

London's perambulators are now equipped with sidelights to avoid danger in the darkened streets

London War Affects Baby Carriages

LONDON has passed an unusual law which requires that baby carriages shall be equipped with sidelights. While no adequate explanation is given, it is believed that the new ruling was put into effect because of the darkness into which the streets are plunged because of the fear of Zeppelin raids. Baby carriages, while not dangerous objects, are objects of danger, and the fact that they are compelled by law to be equipped with a lamp to light their way, lessens the possibilities of collisions. The law requires that the light shall show white in front and red in the rear.

How War Mobilizes the Non-Combatant

ONE of the impressions of war received by Dr. George W. Crile, who served with the American Ambulance at the front, was that a civil community is terrorized when it is first under fire, but that in time this terror wears away and life under the sound of shells goes on quite normally. ("A Mechanistic View of War and Peace," The Macmillan Company).

"I observed that from Furnes to Ypres the farmers were quietly tilling the soil under active shell fire. In one instance just at the outskirts of Ypres I saw a fresh excavation made by a shell which had fallen on a newly-made furrow. The farmer was working at one end of the furrow and the German artillery at the other end. The farmer seemed no more disturbed than the artillery. An aeroplane fight high above our heads called forth the rapt attention of everyone in the fields, on the roads and in the houses, but even so the excitement was less than one usually sees at a baseball game.

"In Ypres, so long under bombardment, and so extensively battered, some of the citizens had stolen back in spite of shells and resumed their daily routine. I recall a little plaster house at the edge of the town, in the doorway of which two women were pleasantly gossiping and two little girls were playing with dolls. The nearer the front one goes, the more quiet and serious every one seems. It is the solemn atmosphere of the consecration of human life."

Adjustable Footrest

AN ingenious German named Stickler has invented a support for the leg below the knee and the foot, which can be easily adjusted to any form of chair or bench and afterwards removed without trouble when the need for its use is over. Thus, one of these footrests can serve a number of seats.

It has always been one of the drawbacks even to the most comfortable of ordinary chairs that while the upper part of the body is well supported, the feet, when they fail to touch the ground, lack a rest. This enables one to work in a comfortable sitting position.

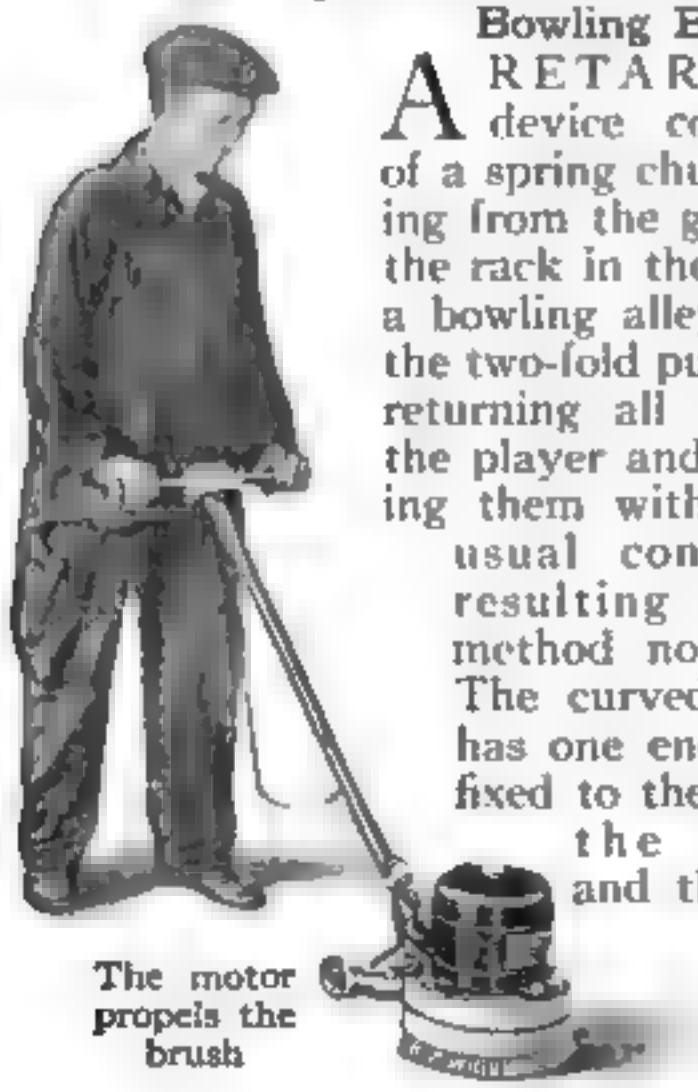
A comfortable foot and leg rest which can be used with any chair

Floor Scrubber Propels Itself

A MACHINE for cleaning floors has been brought out, so quiet in its operation that it can be used in hospitals and so gentle in its action that a frail woman can manipulate it without difficulty. Its chief feature of interest is that it departs radically from the suction or vacuum type of cleaner. Attached to the lower end of a long iron handle is an industrious but small electric motor. As the motor spins, it rotates a circular brush, which can be applied with any desired pressure to the floor surface. Behind the brush motor are two rubber wheels serving a double purpose—to act as a lever for regulating the pressure of the rotating bristles against the floor and as a carriage for rolling the equipment from one part of the building to another.

Because of the brush's rotary motion the machine is self-propelling. Various grades of brushes are supplied for various floor surfaces. For polishing hardwood floors and mosaic or tile, brushes of other types are employed.

Curved Spring Device Returns Bowling Balls

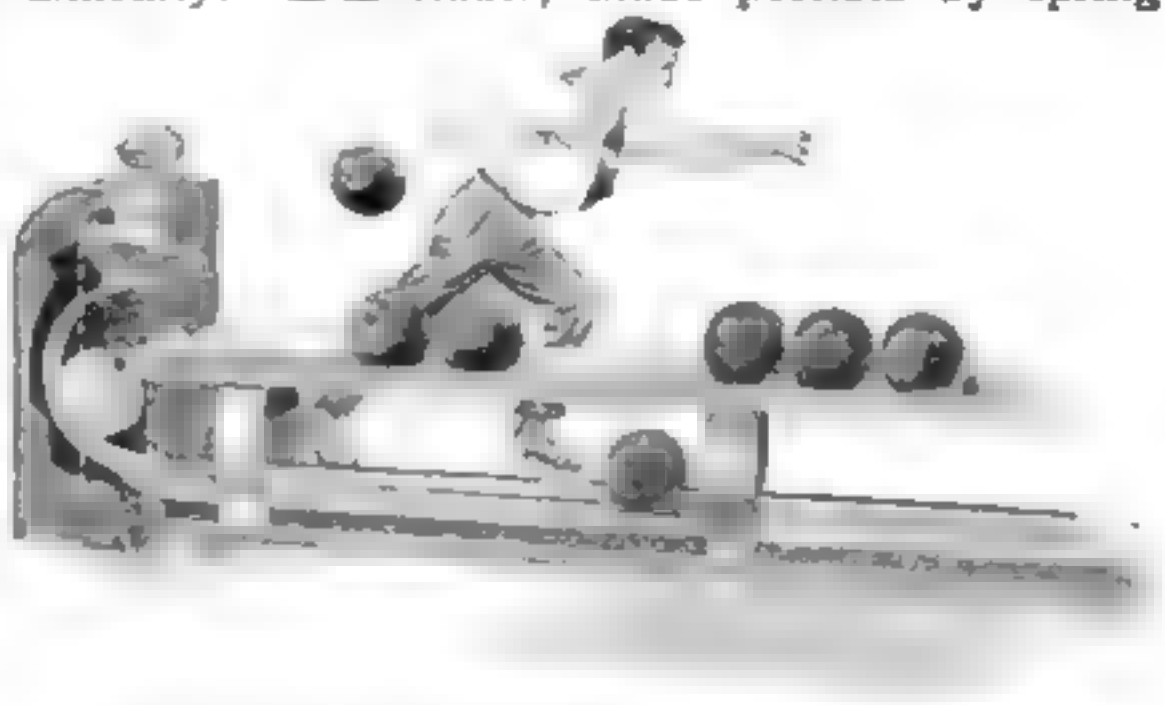


The motor propels the brush

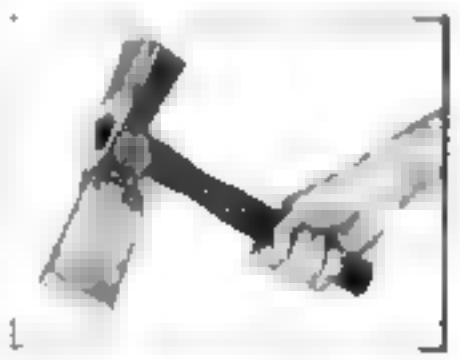
A RETARDING device consisting of a spring chute leading from the gutter to the rack in the rear of a bowling alley serves the two-fold purpose of returning all balls to the player and returning them without the usual concussion resulting by the method now used. The curved spring has one end firmly fixed to the base of the housing and the other to an adjustor. No matter how swift a ball is thrown it is returned to the player with uniform speed.

Detachable Blades for Hatchets

HERE is a hatchet with detachable blades, made possible by spring clips co-operating with apertures and slots of the blades. When attached each new blade is as rigid and stable as the main body of the hatchet itself, and when it becomes dull it can be readily detached and reground. Thus the body of the hatchet becomes continuously serviceable, and one is always assured of a sharp blade. The blades can be economically made by stamping from sheet steel. From the standpoint of pure efficiency the hatchet makes a very effective weapon.



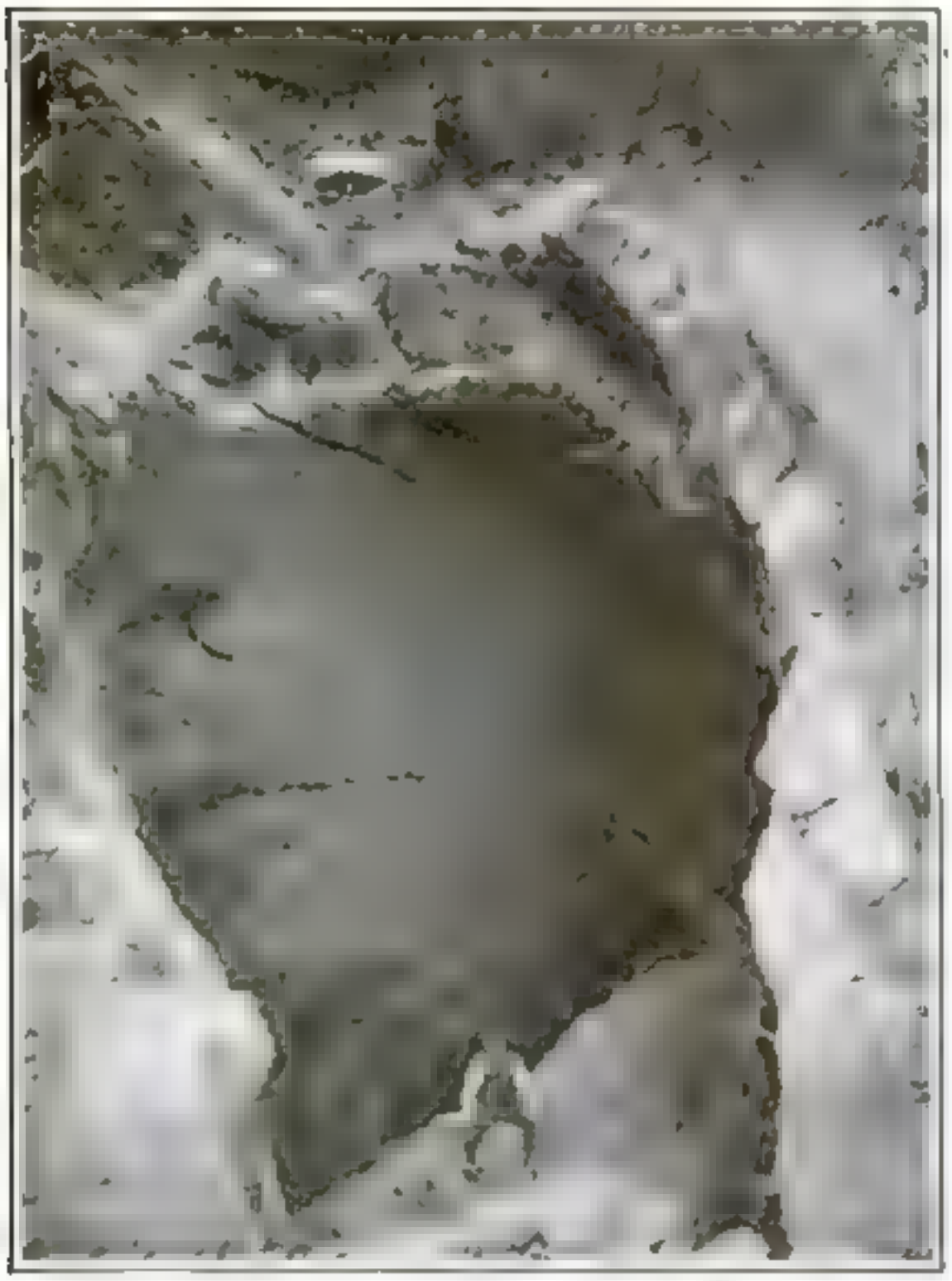
A simple spring device retards the balls as they return to the player



A detachable blade

Listening to an Electric Current

AN interesting electrical experiment, illustrating the fact that sound accompanies the passage of electricity through the body, can be shown in the following manner: Let two persons each hold an electrode from a small magneto or shocking-coil. Let one person, with his free hand, touch the other person behind and just below the ear. A buzzing sound, otherwise inaudible, can be heard. The tone of the sound depends upon the number of interruptions of the current.



When the Appalachian Mountains were lifted above sea level, millions of years ago, these strata of limestone were arched up like a bubble in pie crust. The core of the rock has been partly mined out to make cement

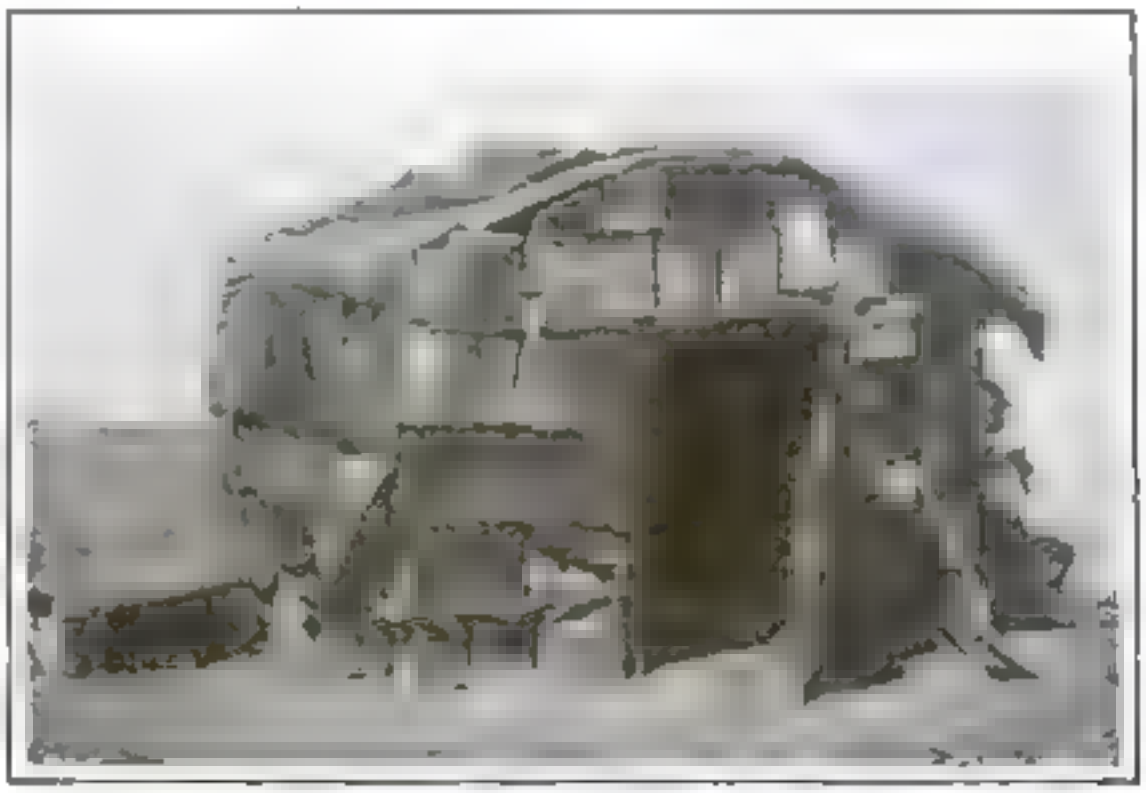
Rock Folded Like Cardboard

THE rocks in this photograph which are seen to be bent over in the shape of a loop were at one time—some millions of years ago—the flat bed of the ocean. When the Appalachian Mountains were uplifted above the sea they were raised with the rest of the land, and as the uplift was irregular these strata of limestone rocks were bowed up like a bubble of a pie-crust, which is lifted by the gas generated in the cooking of the pie. The core of this rock has been mined out for making cement. The remaining rock is also limestone, but as it is not of the proper consistency for making the best cement, it was left intact.

When rock is bowed or arched up in this manner, the result is termed an anticline. This anticline is exposed at several points along the Chesapeake and Ohio Canal, Maryland.

The House That Tin Cans Built

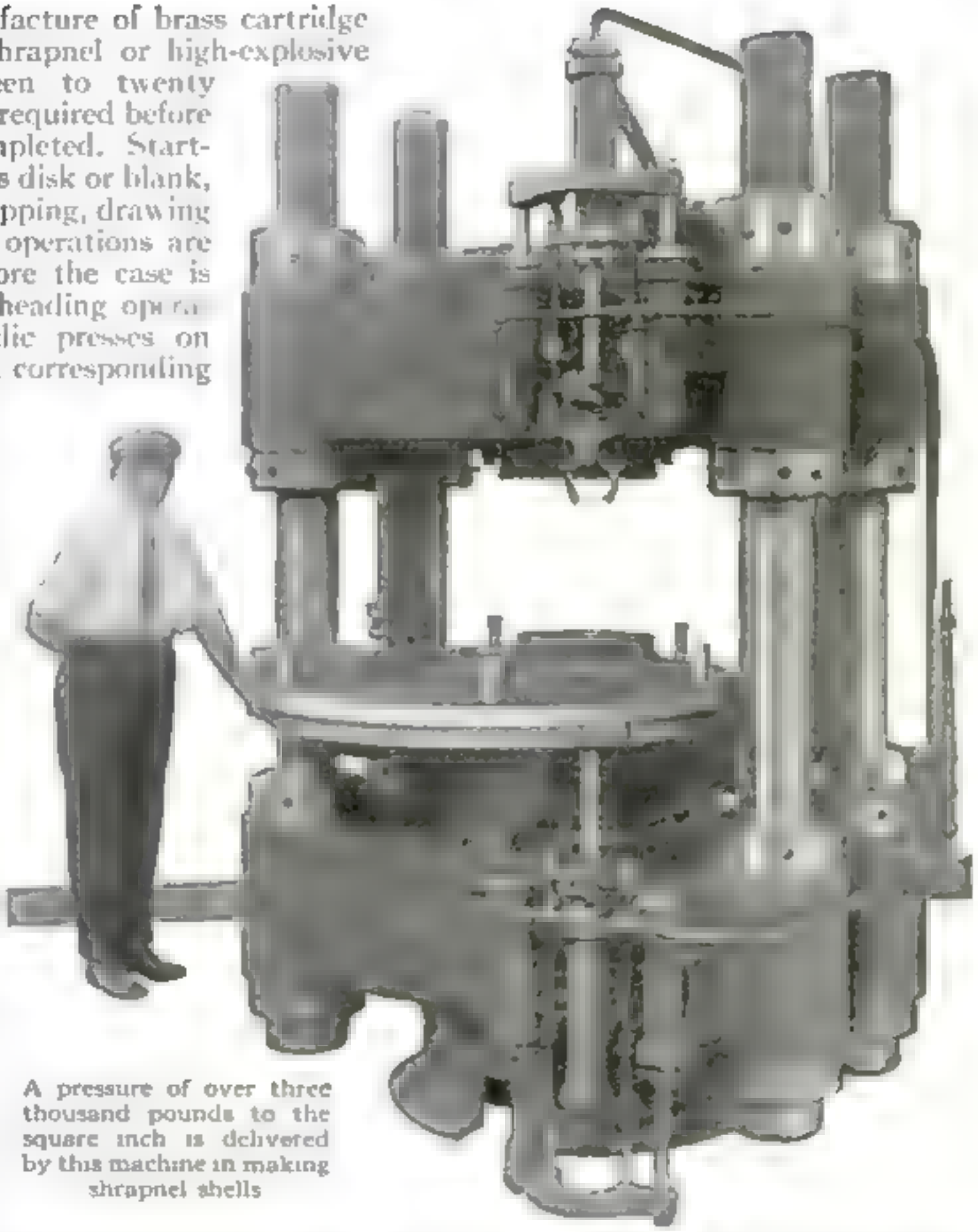
YOU have heard of the house that Jack built and you may have read about the house that junk built, but did you ever hear about the house that tin cans built? Huts built from tin cans—five gallon gasoline cans—are not at all uncommon in that section of America between the Rio Grande and the Tierra Del Fuego, as in the locality the five gallon can is a generally accepted standard of liquid measurement. While not entirely suited for a dwelling in Mexico, because it is not bullet-proof, this tin can house is very comfortable.



There is no such word as "can't" for the man who built this house; but he uses can frequently, his house being made of five-gallon gasoline cans

Giant Press Used in Making Shrapnel Shells

IN the manufacture of brass cartridge cases for shrapnel or high-explosive shells, fifteen to twenty operations are required before the case is completed. Starting with a brass disk or blank, a number of cupping, drawing and indenting operations are performed before the case is ready for the heading operation. Hydraulic presses on which dies and corresponding punches are employed, are used for all of these operations. A very powerful hydraulic press is used for the heading operation which is shown by the accompanying photograph.



A pressure of over three thousand pounds to the square inch is delivered by this machine in making shrapnel shells

The heading operation is accomplished by inserting a "fullering-block" exactly matching the indention previously made, between the head of the press and the top of the cartridge case, the latter being held in place by a suitable die. As the pressure is applied the fullering-block causes the brass to flow outward in all directions, thus forming the head of the shell. The pressure is furnished by a motor-driven, triplex, hydraulic pump, which delivers water at a pressure of thirty-two hundred and fifty pounds to the square inch.

The press has a revolving turret with dies to receive three shells. This provides for an almost continuous operation, as there is always one shell awaiting the heading operation and one shell being unloaded, while the other shell is undergoing the heading operation. The rotation of this turret is controlled by an indexing device, so that the shell is accurately held in place directly beneath the fullering-block.

The photograph shows a rear view of the press. The lever controlling the indexing device is shown at the extreme right.

A Switchman Who Became Judge, Though Armless

DAVID Moylan was formerly a switchman on a Western railroad Through an accident he lost his right arm, but he refused to relinquish his position. Only when he had lost his left arm, through a second accident, did he turn to something else. Then he began the study of law and showed marked ability. With his examinations, however, came the first big handicap; but this man who seems undismayed at anything, proceeded to learn to write not only proficient but popular, he was elected to the City Council of Cleveland, Ohio, where he resides. He was as successful in this office as before, and was re-elected at the end of two years. Recently he ran for the office of Municipal Judge and won.

David Moylan was once a switchman, he is now a judge. Did an accident force him to rise to his present success, or would ambition have elevated him to equal responsibility? At any rate, he succeeded where many less unfortunate would fail.

by holding a pen between his teeth. Using this method, he took the examinations, proving not only his mental ability, but good penmanship as well, for he can write better with his teeth than many persons can with their right [illegible]

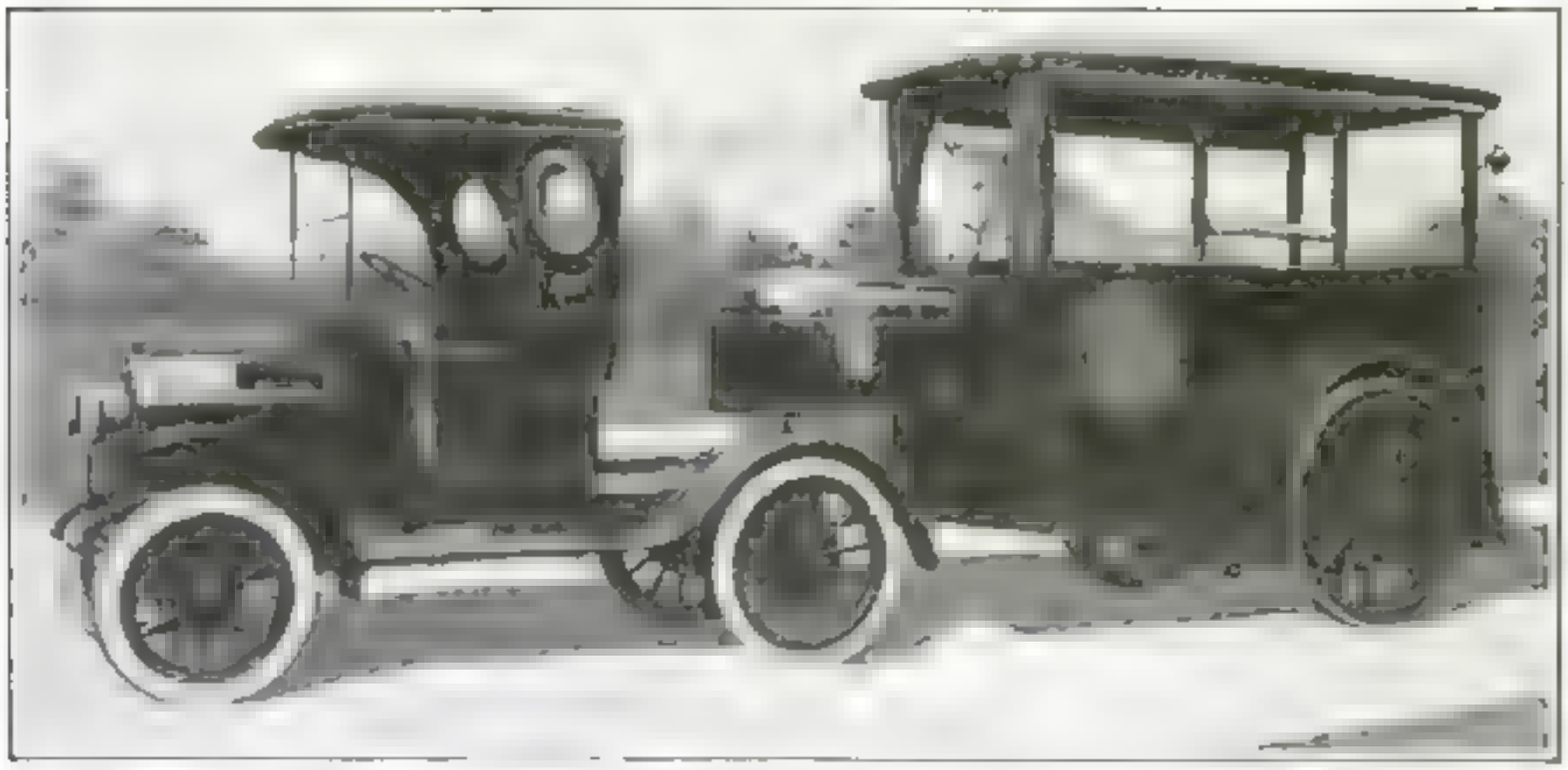
After becoming a lawyer, he practised in that profession for four years. Becoming

Judge David Moylan lost his arms in two different accidents while employed as a switchman on a western railroad

Why We Can See Through Water

If you go to an aquarium and look at the fishes or other animals that live in the water, you will see that in one case water may be very clear and transparent, and in another may be only half transparent. There are really all degrees possible.

When the waves of light pass through a translucent thing like frosted glass, they are twisted and broken and mixed. That is why you can see some light coming through, although you cannot make out things on the other side. But transparent glass lets waves of light come through it almost exactly as they come in, so that sometimes you are not sure whether the window pane is there or not. Water is much the same as glass in this respect. If there are no solid substances in the water, and if the water is still, it is very fairly transparent. Neither water nor glass nor anything else lets through absolutely all the light that comes to it. It keeps back at least a little, just as the air itself does with the light of the sun.



Every consideration is given to the injured horse in carrying him away to the hospital. This truck differs from the ordinary automobile ambulance in having a trailer

A New Type of Motor Horse-Ambulance

DIFFERING from other previous types of motor ambulances for sick or disabled horses in that it is a truck and trailer principle and not a self-contained vehicle, the latest unit, as shown in the accompanying illustration, has a low platform trailer into which the horse may walk with ease or be hauled in on a special device if unable to stand up.

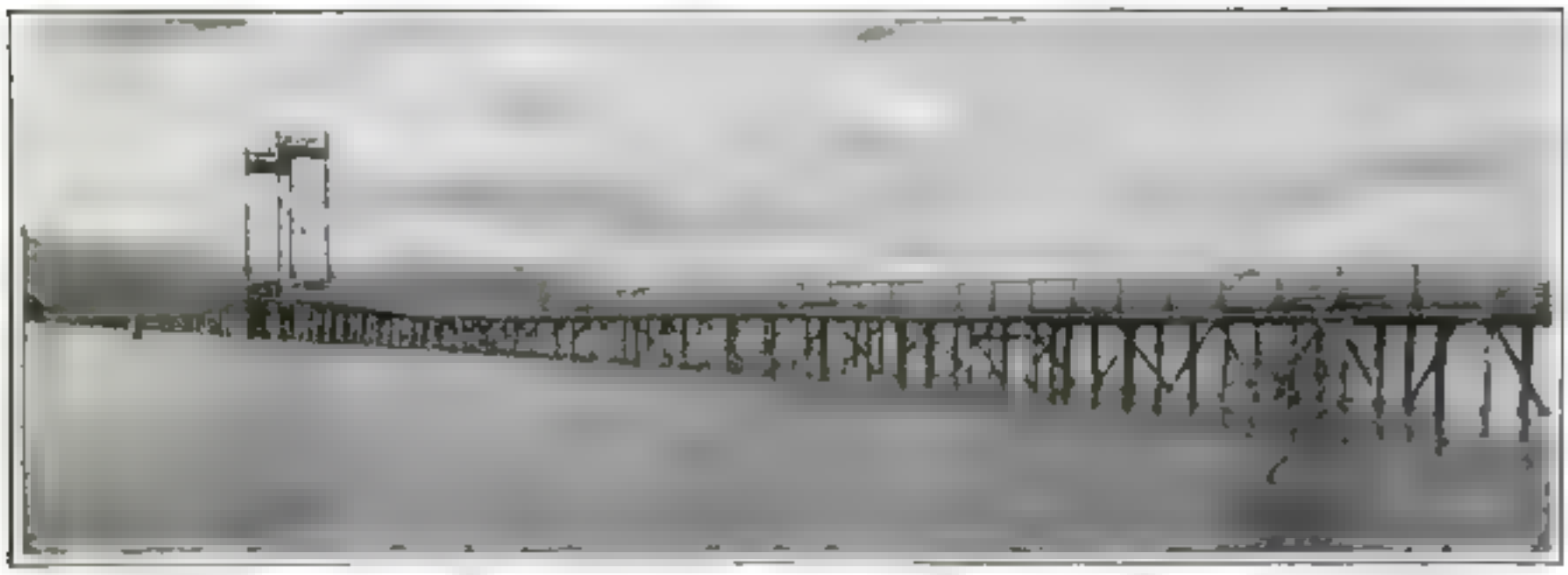
The new equipment consists of a one-ton motor truck and a trailer, the forward end of which is supported on the truck. The trailer has a specially low platform and a tail-gate which may be swung down to form a bridge to enable the sick horse to walk into the trailer body with ease. A second independent floor on rollers is provided in the trailer. When the horse is so disabled that he cannot stand up this platform is rolled out of the trailer and down the lowered tail-gate to the street, where the animal is securely bound to it with his head on a pillow to prevent injury. The platform is then hauled into the trailer by means of a steel cable wrapped around a drum carried in the gooseneck of the trailer-frame and revolved by a hand-crank as shown in the illustration.

The trailer is provided with a permanent top and curtains at the front, rear and sides for use in inclement weather. Two stanchions are provided at the center of the trailer at each side to support the ends of a canvas sling passed under the stomach of the horse to take the weight off his feet when one of his legs is injured.

Germany's Rubber Trade

THE war has had its effect on the rubber trade in Germany. The manufacture of rubber sporting goods, toys, articles of luxury and the like has been almost entirely curtailed. Had a demand existed, the lack of the necessary raw materials, even in substitute qualities, would not have been forthcoming. Business is very slack in sanitary and surgical goods, because the essential, fine crude rubber can only be had for military purposes and skilled labor, which is very important in this line, is very scarce.

The enormous consumption of solid and pneumatic tires by the German army has given the manufacturers all they can handle. Business decreased appreciably, however, towards the close of the year 1915. The cycle tire industry has not been favored by war conditions. Only reclaimed rubber has been available for making casings and only very limited quantities of crude rubber have been allowed for inner tubes. The restrictions on the use of cotton fabrics has practically stopped the making of cycle tires for other than military purposes.



A bridge, two miles in length and twenty feet wide, is stretched across Pen d'Oreille Lake, for the use of farmers who sell their produce in Sandport, Idaho

The Longest Wagon-Bridge in the World

IN the accompanying photograph is shown a bridge two miles long, twenty feet wide and twenty-five feet high. The tower in the center is the drawbridge through which vessels pass. By turning a heavy iron wheel the weights at the top of the tower are lowered to throw the bridge open.

This bridge is on the Pen d'Oreille Lake, and was built for the benefit of the farmers across the lake, as they had no other way of getting across water to Sandpoint, Idaho, to sell their produce and do their marketing.

Healing Magic of the Electric Arc

THE most intense heat produced by man is that of the electric arc, and the possibilities of its application in various branches of American industry have only begun to be realized. Like many other useful scientific agents, the electric arc has been adopted by the burglar. There is no safe known that will not yield to the electric carbon applied by the skilled "safe-cracker."

Aside from lighting, the most useful purpose to which the electric arc has been put is in the mending of broken or cracked castings and metal parts of all kinds. A broken shaft, for instance, can be resurrected from the junk heap if a skilled workman, with adequate arc apparatus, is given a chance at it. Moreover, a broken metal piece repaired by the electric arc is as serviceable as when new. In fact, strain tests made upon repaired castings often result in breakage at a different point than where the repair was made.

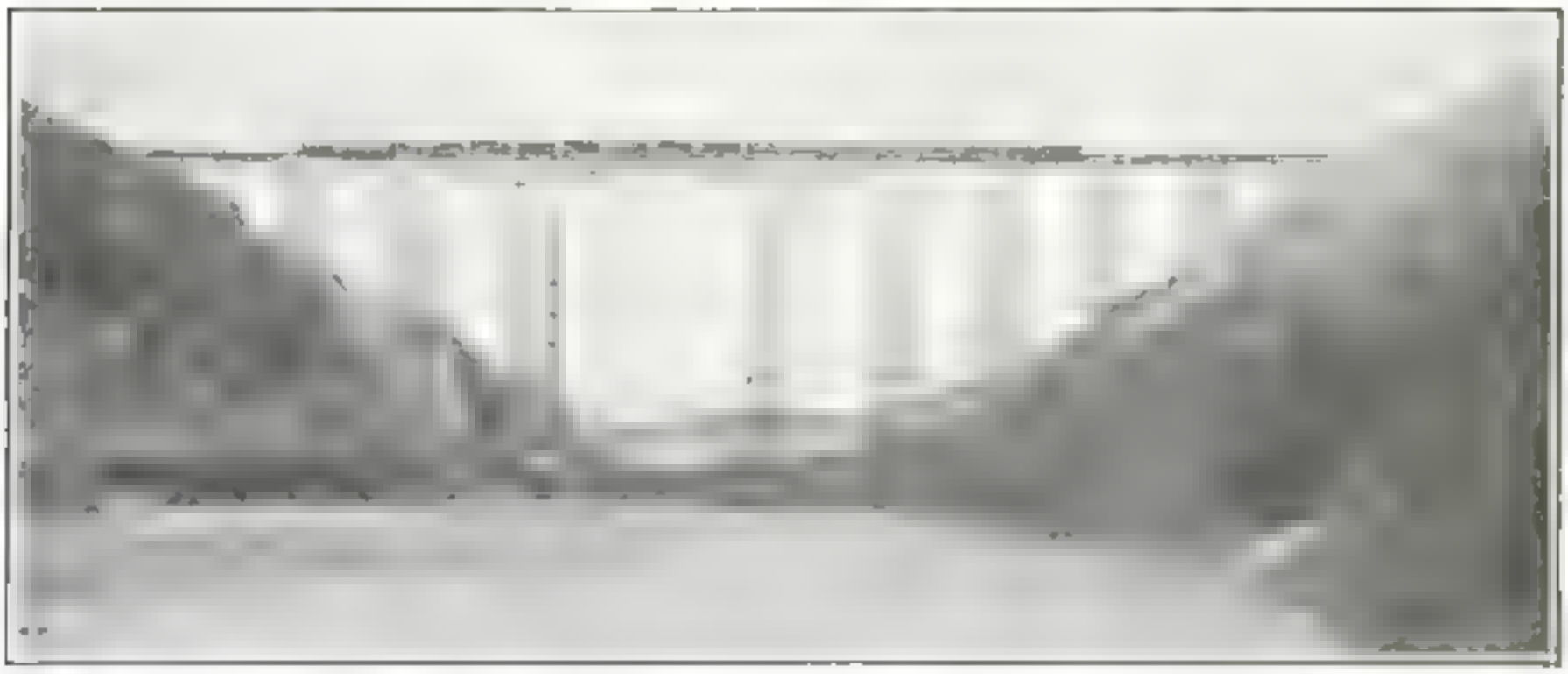
The accompanying photograph shows a workman engaged in arc-welding. Due to the intense heat at the point at which the carbon pours its electrical fire upon the metal, the operators usually wear helmets, not unlike the gas helmets of the present war. They at least hold between their eyes and the arc a thick plate of cobalt glass. The amount of protection required depends upon the strength of the current fed to the arc.

Broken or cracked castings can be quickly mended by means of an electric arc

---

Watch Your Oil for Gold Teeth

WHILE overhauling an old, two-cylinder car, E. E. Booth, of Pomona, Cal., found in the crank case a sizable piece of refined gold which had apparently been once the crown of somebody's tooth. Its presence in the oil and other residue has not been explained.



The guarding of this railroad bridge across the Pecos River on the Mexican frontier was accomplished by means of acetylene search-lights located on the banks below the bridge

Protecting a Bridge from Villa with Acetylene Lamps

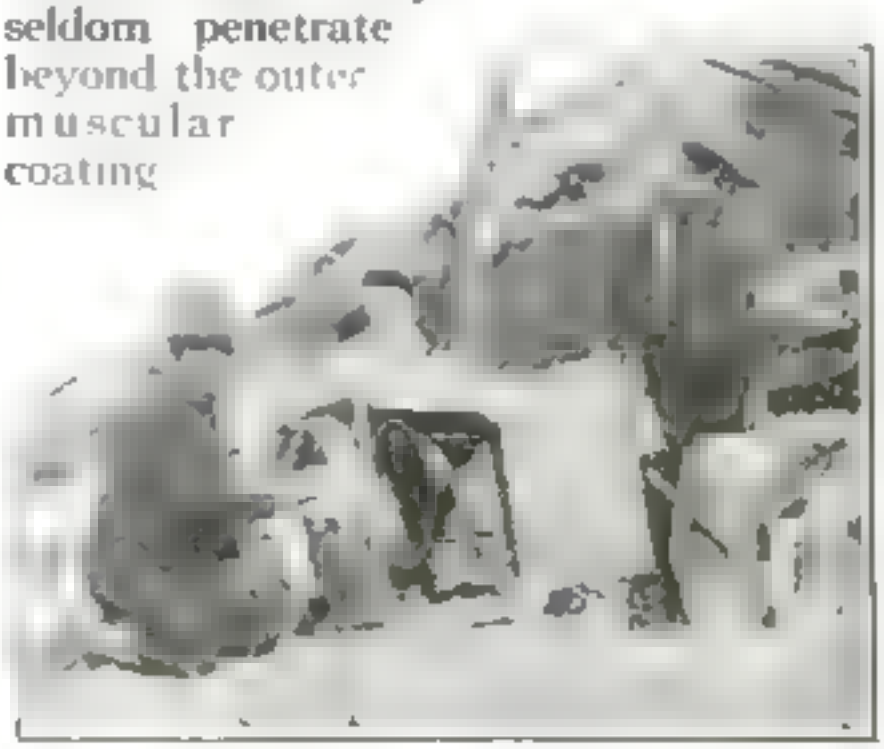
DURING the trouble in Mexico it was feared along the frontier that the Mexican desperadoes might destroy American bridges, thereby preventing, or more or less seriously hindering, the effort of the American troops ordered across the border in capturing bloodthirsty Villa.

On several occasions bands of marauders threatened to dynamite the bridge of the Southern Pacific Railroad, which stretches, a delicate steel thread, across the Pecos River. The Southern Pacific Railroad bridge which is three hundred and twenty feet in length, spans the lower course of the Pecos River where it flows into the Rio Grande. The bridge is one of the most important connecting links in the southern branch of the Texas division of the railroad, and its demolition, a comparatively easy matter, would cause a tremendous loss because of the delay in freight shipments. To forestall the plans of a possible Villa dynamite squad, troops were stationed at regular points along the roadbed of the river. At several places underneath the bridge, powerful acetylene search-lights were turned on at night. Because of the vigilance of the 19th United States Infantry, which was stationed on the bridge, the Mexicans made no attacks.

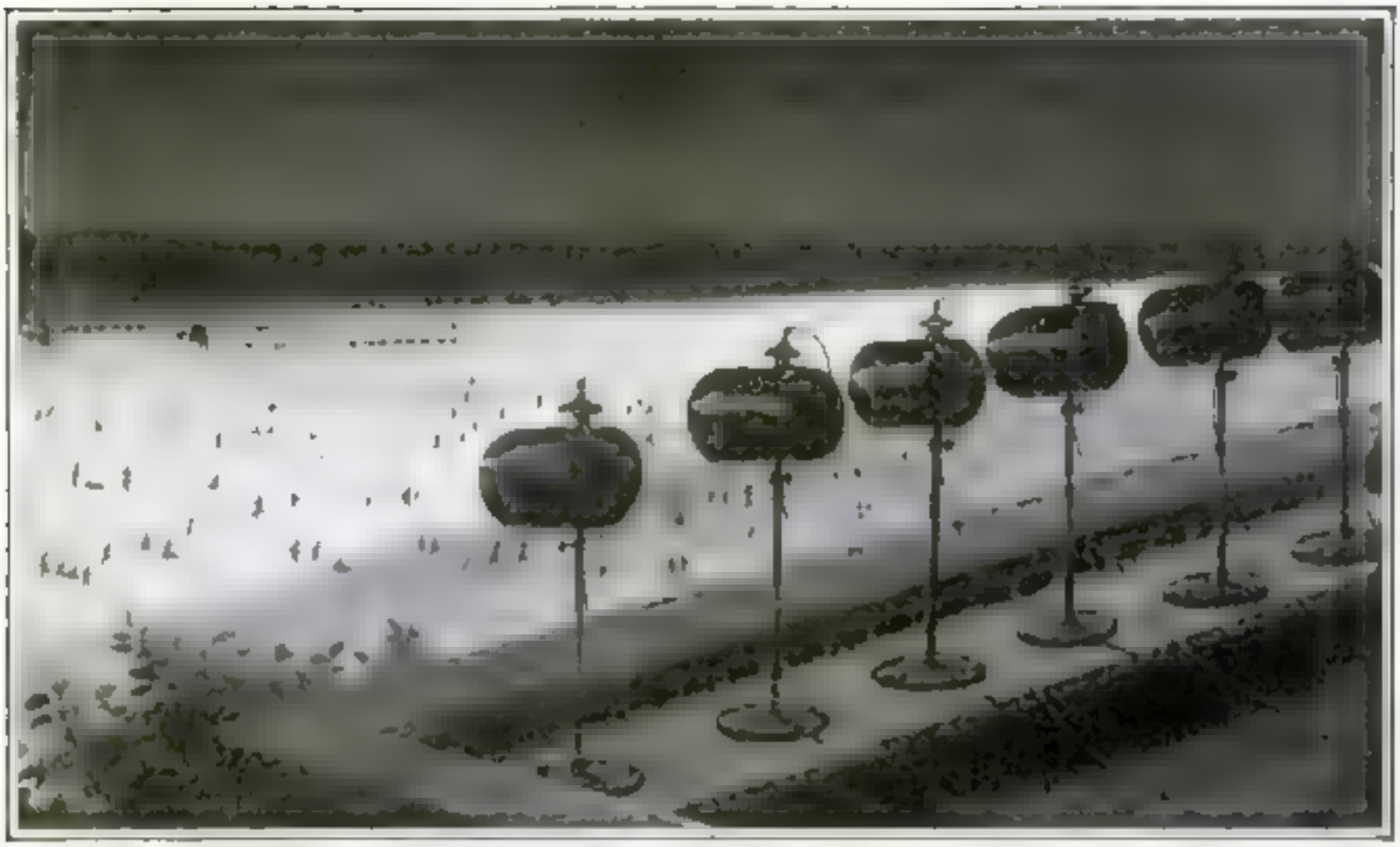
The Gentlest Bullet

A CAT may be killed by shooting, but the use of chloroform is generally considered more humane. Shooting has its merciful side also, and during the period of the present war, much has been said regarding the most humane bullet. The bullet used by the French infantry cannot be said to be desirable, yet it is perhaps the least painful and produces the fewest bad effects of any now in use. Its swiftness enables it to pass right through the body and to cut a very small, clean hole, without tearing the surrounding tissue. The chance of escaping important nerve centers is thus greatly increased.

The greatest injury is caused by tearing open the tissues and splitting the bones. Many heavy bullets act in this way as well as the dum-dum bullets, so much talked about last year. Shrapnel balls are not so disastrous in their effects. They have so little force back of them that they seldom penetrate beyond the outer muscular coating



Vigilant American troopers kept the calcium focused on the delicate steel structure all night



Bathing under the glare of the calcium has become a popular recreation at some of Chicago's extensive beaches on the shores of Lake Michigan

Swimming by Searchlight

FOR the benefit of the tired business man and the tired business woman, unable to take advantage of Chicago's twenty-two miles of lake front during the daytime, the city has installed along some of the beaches powerful electric searchlights, so that the bathers can see just where, and with whom, they are swimming. After nightfall, the lights are turned on, throwing their rays in various directions, so that the bathers have plenty of illumination both on the beach and at a generous distance into the lake.

Aside from giving the Chicagoans a new form of water sport, it makes their swimming perfectly safe.

A Strange Persian Cistern

PERHAPS nothing could better illustrate the difficult nature of Persia as regards military operations than the accompanying photograph which shows the extreme measures that have to be adopted for the conservation of water over a large part of the region in which the Turks, Russians, and even a considerable number of Persians are now in conflict.

The Caspian watershed of Persia is fairly well watered and wooded, but all the region south of about the latitude of Teheran—the central and southern zones—are almost absolute desert, the largest cities being near the base of the mountains where the rivers have not had time to be absorbed in the burning sands. At other points there are occasional wells and springs, but the principal sources of water in these desert regions are the strange cisterns such as shown in the illustration. Stone conduits carry water from the mountains to the cisterns on the desert plains.

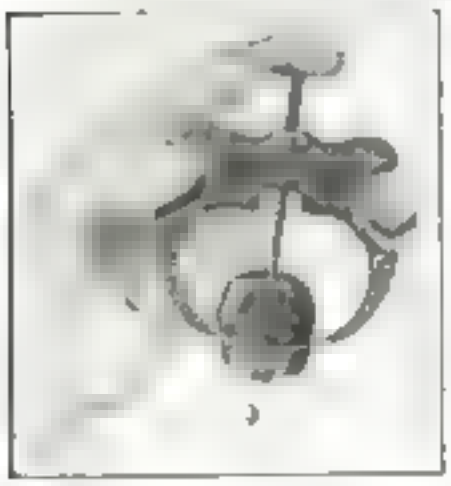
Water is carried many miles through conduits and deposited in these remarkable dome-covered Persian cisterns

Housekeeping Made Easy

How to Avoid Burnt Fingers

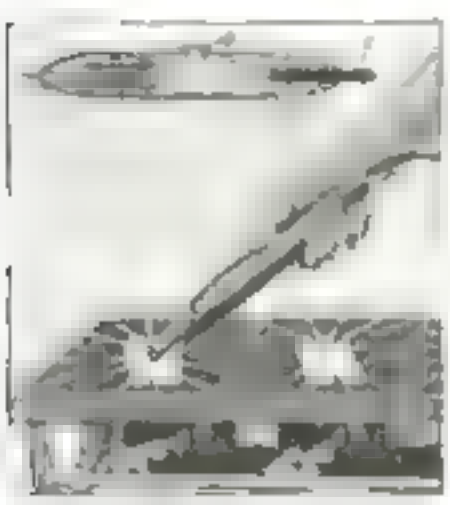
WHERE is the cook who has never burnt her hands draining scalding hot water from vegetables? Blistered hands may now become mere reminiscences, for there are upon the market excellent vegetable kettles of aluminum with lids held in place safely by clamps. On one side is a hand-hold for tipping the vessel and for holding the lid.

Cherry-Stoner Saves the Hands



AN automatic method of removing the stones from cherries without touching the fruit with the hands or soiling it in any way, is afforded through the operation of the simple little device illustrated. Press the finger on the spring-rod, so that it goes through the fruit and reaches the stone, and continue pressing until the stone is forced out.

An Electric Gas-Lighter

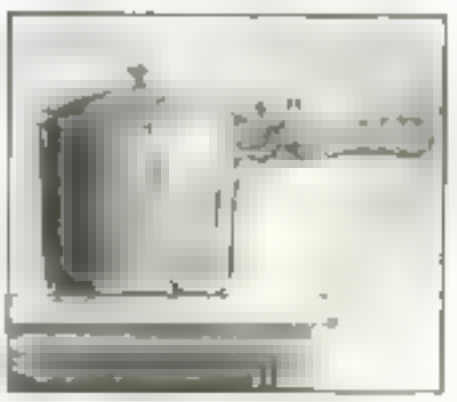


A GAS-LIGHTER which can be attached to an ordinary electric socket has recently been patented. A tubular insulating handle *A* contains a bank of electrical resistance *C* to which is connected a metallic leaf spring. By pressing a push-button *D* on the side of the handle the spring is brought into contact with a carbon electrode *E*. Connecting with the resistance coil is a wire *D* which, in turn, connects with the house circuit.

Efficiency in the Kitchen

THE cook, like most other responsible people, is depending less on her guessing apparatus and more on simple little instruments which insure accuracy. For instance, there is the kitchen clock, the graduated pint measure, scales of one kind or another, thermometers, etc. The graduated measure has superseded the various sized teacup.

Two Cooking Vessels in One



A COOKING utensil which comprises inner and outer vessels separated from each other and permanently connected together at their upper ends to provide a closed heating chamber which extends from the bottom of the outer vessel to the upper ends of both vessels, is able to distribute heat more effectively throughout the food in the upper portion of the inner vessel.

A Glue-Brush Like a Fountain-Pen

NOW comes a glue fountain that applies glue through a brush by pressure, doing away with the time consuming task of dipping and applying. Liquid glue is contained in a long metal barrel in which an inner barrel fits piston-like. At the lower end of the outer barrel is a small curved tube which points towards a brush. Forcing down the inner barrel urges the glue into the bristles of the brush.

A Vacuum Washing-Machine Which Sucks Dirt Out of Fabrics

CONICAL vacuum cups which see-saw up and down, do the washer-woman's hard work in the laundry machine devised by E. F. Beebe of Minneapolis. Besides saving rubbing, the cups cleanse the clothes with practically no wear and tear on the fabric.

The tub rotates beneath the cups, thus enabling them to reach every part of the washing. The wringer is pivotally hinged at one side of a post of the frame that supports the tub. It can be swung close up to the tub, or it may be swung to one side when the machine is to be used with a fixed tub. An electric motor usually furnishes the power, but a gas-engine may be used instead.

Try These

ONE of the latest household appliances is the hot-water platter. It is especially useful at breakfast time. Boiling water can be turned into the tank under the platter and the top screwed down. Then by placing the nickel cover over the food, it will keep hot for at least a half-hour.

Before cleaning tan or russet shoes, rub them over lightly with a flannel cloth wet with milk, first removing any stains with benzene. If this is done, the shoes will receive the polish much better and remain in a softer and more pliable wearing condition.

When hooks and eyes are used on the placket of a tailor-made suit, if the pair at the base of the opening are pinched down flat the placket will never tear or look shabby.

A good furniture polish can be made in the following manner: To six ounces of the best refined kerosene add one ounce of the best yellow resin, one dram of vermilion to color, and ten ounces of turpentine. Mix these ingredients at a gentle heat for at least an hour. Then strain and stir constantly until cold.

A canvas or linen household pocket, or sidebag, with a belt, will be found a great step-saver for the busy housewife In it may be stowed such articles as keys, pocketbook, memorandum pad and pencil, so that they are ready at hand.

Paint stains may be removed from cotton or linen by soaking in turpentine or benzine. If on silk do not use turpentine; ether will probably dissolve it.

Grass stains, when fresh, can be removed by soaking in alcohol. If the stains are old, rub with molasses and allow to stand several hours before washing out.

A number of electrically operated vacuum cups cleanse the clothes with very little wear and tear on the fabric

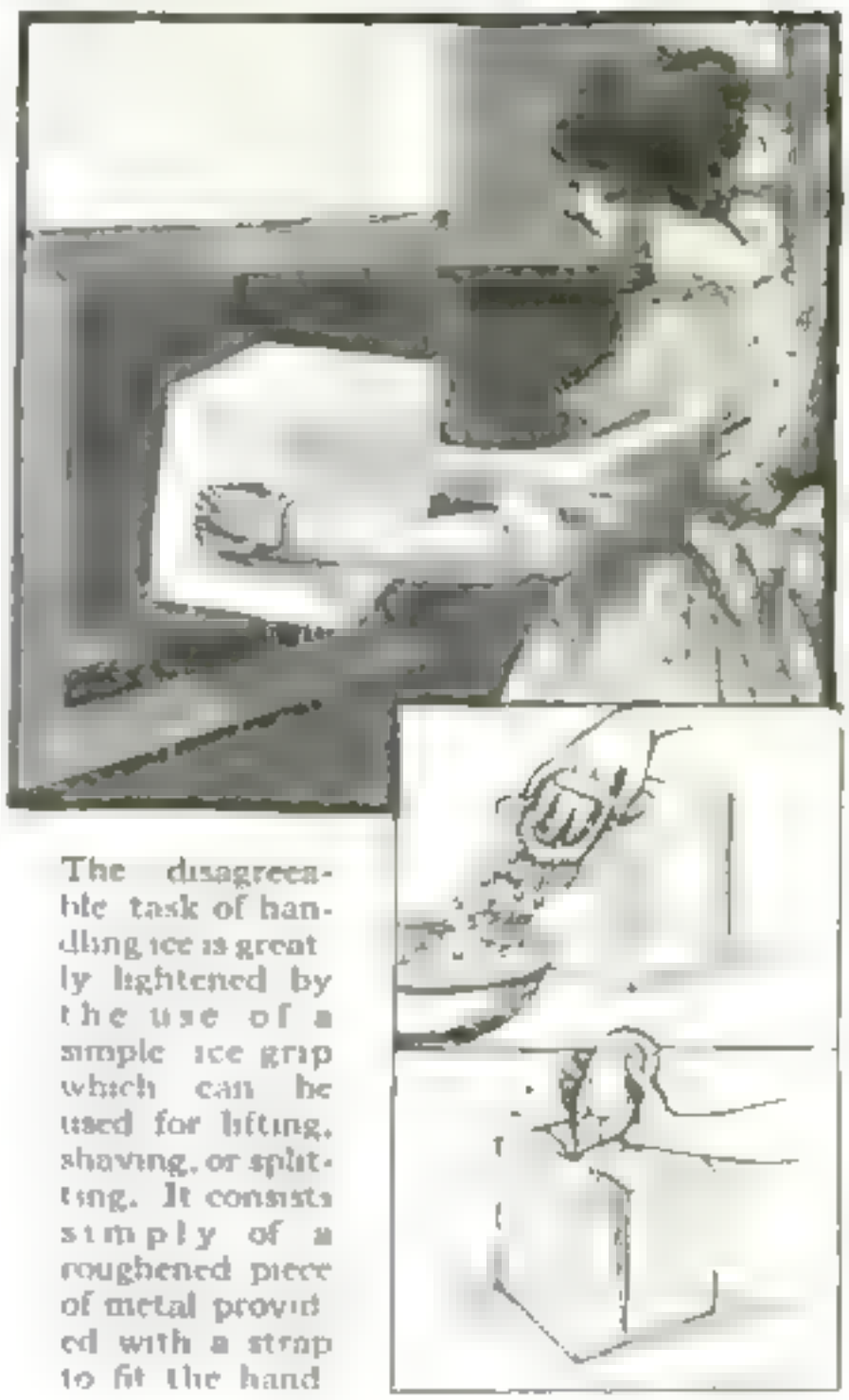
A Convenient Milk and Butter Slide for Refrigerators

OF all the foods kept in a refrigerator milk and butter require the most frequent opening of the food compartment. They are removed for each meal, returned after the meal, and are taken out between meals for use in cooking. When they share the usual large chamber the entire compartment is opened to the warm air each time. A new refrigerator accessory is a milk and butter slide arranged separate. It reminds one of a drawer in an office filing cabinet.

Upon opening the small door a metal skeleton slide appears, so divided, that it holds two one-quart milk-bottles and three one-pound bricks of butter, each bar of butter resting on a removable sanitary tray which can be carried to the table. Only one-tenth as much cold air is lost as when the door to the main provision chamber is opened. The metal slide is plated with zinc, and nickel.

Not only does this arrangement prevent the rapid melting of the ice, but there is another advantage. Butter and milk absorb odors and vapors given off by other substances. This difficulty is obviated by means of this device and the odor of onions, meat, etc., does not reach the butter and milk.

Butter and milk should be kept separate from the other foods in the refrigerator



The disagreeable task of handling ice is greatly lightened by the use of a simple ice grip which can be used for lifting, shaving, or splitting. It consists simply of a roughened piece of metal provided with a strap to fit the hand

An Ice-Grip With Many Uses

THE slippery, cold block of ice delivered by the iceman can be grasped safely by holding it with a pair of ice-grips. Each grip has an oval, roughened face to make contact with the block. On the back of each is a strap for the hand. For its second use a grip becomes an ice-pick. At one end is a sharp point for this purpose. When shaved ice is wanted a grip becomes an ice shaver.

Another Way to Rejuvenate Eggs

A MARYLAND man has found a means of preserving eggs with a substance known as "liquid petrolatum," which he claims will rapidly penetrate eggs, when applied externally, and make them proof against moisture or bacteria. The preserving substance is a mixture of hydro-carbons. When properly treated, eggs can be preserved under a normal temperature for many weeks without deteriorating.

Measuring the Light of the Stars

By Joel Stebbins
Professor of Astronomy in the University of Illinois

Prof. Stebbins' remarkable measurements of the heat of stars have attracted the attention of astronomers all over the world. Apart from the value of the results obtained, his work is interesting because it shows that astronomers are making use of modern technical advances, as in the case which he describes, sometimes before they are perfected for commercial purposes.—EDITOR.

ONE of the standard problems of astronomy is the exact determination of the amount of light that comes from each of the stars. Not that the knowledge of the fraction of a candle power of each star is of any interest or importance, but that the measures are valuable for future reference, especially to determine the gradual changes in light caused by the dying out or the brightening of these distant objects. Our own sun being one of a class of stars, the best clue to the life history of the sun may be given by a study of other bodies of the same kind. We also find in the sky numerous extraordinary objects, called short-period variable stars, which change in brightness by fifty per cent or more in the course of a few days, or even hours.

Wanted: A Standard Eye

For general purposes the unaided human eye is one of the best instruments for measuring the light of stars, and most forms of photometer depend ultimately upon the eye for a comparison of two lights. Because of the difference between individuals, however, there is no such thing as a "standard eye," and astronomers have long been waiting for some purely mechanical device which will register light intensities. Let us note that such an instrument is even more in demand for commercial work, especially for testing electric lights. At present the ordinary householder has to take the word of somebody else for the amount of light he is getting from electric lamps. The lighting companies accommodate us with meters telling how much current we use, but we have no exact measure of how much light they are delivering. City authorities contract for a number of lamps of say one thousand candle power each, but who knows after the lamps are installed whether they furnish a thousand or only eight hundred candle power?

We see that there is a real demand for an instrument which, held at a given distance from any lamp, will indicate just how much light is being emitted. Needless to say, many experimenters have attempted to perfect such an instrument, but so far without success. The underlying principle of these devices has been to make use of some substance which changes its properties under the influence of light. One of the most important is the element selenium, a substance in the same chemical group as sulphur. For more than a generation it has been known that the crystalline form of selenium changes its electrical resistance when exposed to light. Other substances exhibit this same property, but none to such a marked degree as selenium. The ordinary arrangement is called a cell or bridge. Two wires are wrapped about an insulator, and on one face the selenium is deposited and then sensitized. The best method of sensitizing is a trade secret, but one standard method is to melt the selenium at four hundred and twenty degrees Fahrenheit, and then let it cool gradually, when it will crystallize and be light-sensitive. There must be a certain amount of mystery in the process, even to the makers themselves, for none of them can furnish cells of a standard resistance, nor even two cells which are precisely alike. On the opposite page is shown an unmounted cell of the usual form. In the dark it has an electrical resistance of about five hundred thousand ohms, but on exposure to strong daylight the resistance drops to about ten thousand ohms, or only one-fiftieth of the original.

The principle of a selenium photometer is, then, to connect a selenium cell with a small battery and to measure the

increase of current, due to light, by means of an ammeter or galvanometer. However, there are several difficulties in this simple process. When selenium is exposed to a strong light, some minutes or even hours are required for the resistance to return to its original value. Selenium is extra sensitive to red light, and so does not give directly a measure of how bright a light would appear to the eye. For instance, a carbon filament lamp with its yellowish light will affect a selenium cell just as much as a much whiter tungsten lamp of double the candle power. Finally and worst of all, selenium is very irregular in its action, and no experimenter has yet solved to his own satisfaction the mysteries of this element.

The Selenium Cell Is Packed in Ice

As applied to the stars, however, many of the ordinary difficulties disappear. Star light is so faint, even at the focus of a large telescope, that the slow recovery of the selenium is not such a drawback; next, since we are usually concerned only with variations of light, it matters little which color is used; and lastly the irregular action may be controlled somewhat by keeping the selenium at a low uniform temperature. Strange as it may seem, when the light of stars is to be measured, a selenium cell at the end of the telescope is surrounded with an ice pack, the ice being renewed every day in sum-

In the circle is shown a selenium cell and ice pack attached to the telescope

The oval diagram above the circle pictures the system of Delta Orionis, showing orbit, eclipse positions, and comparative size of the sun

To the right—Unmounted selenium cell, natural size

mer. Such an arrangement is shown in connection with the telescope of twelve inches aperture at the University of Illinois Observatory. Wires are lead from the telescope to a galvanometer in an adjacent room. Two observers are necessary, one to point the telescope and ex pose the selenium cell to the stars, while the other reads the galvanometer and records the measures.

With this short description of the device, let us see how results are obtained on the stars. Nearly every one has heard of the wonders of spectrum analysis; how, by studying the light of a star, split up into the different colors, the astronomer has been able to draw certain conclusions about the constitution of the body. For example, it is easily demonstrated that metals, such as iron and calcium, exist as hot vapors above the surface of the sun. It is not so well known, however, that by means of the spectroscope we can study the motions of the stars as well as their chemical constitutions.

It would lead us too far afield to discuss this phase of the subject, but let us state that peculiarities in the spectra of certain stars lead us to conclude that they are attended by large companions or planets which move about them. Such stars are called "spectroscopic binaries," since they are revealed by the spectroscope. The North Star is an object of this class, being in fact a triple system, as there is one body which revolves about the main star in only four days, while a second and more distant companion has a period of a dozen years. In some cases the planes of the orbits of these companions are at such angles that when they pass in front of the main stars there are eclipses as seen from the earth. About one hundred such cases are known, but more are being continually found. The study of these eclipsing binaries is especially important, since they give us the most direct measure of the diameters of the stars. Spectroscopic measures determine the size of the orbit in which the second body moves, while with the photometer is found the duration of the eclipse, which is simply the time necessary for the companion to pass in front of the main star, and hence gives at once the sum of the diameters of the two bodies.

The Stars in Orion

Any one who is familiar with a few of the constellations knows Orion, which is in the south in the winter sky. The striking feature of this group consists of three stars in a row, known as the Belt of Orion. The right hand star of the three is Delta Orionis, the Greek letter, Delta, meaning the fourth star in the order of lettering. This object is a spectroscopic binary, the period of the companion being six days. The star was one of the first observed with the selenium photometer, and by comparing it with other stars in the vicinity it was soon found that at intervals of six days there is always a loss of eight per cent of the light, an amount imperceptible to the eye. The eclipse lasts slightly less than one day. After an exhaustive study, the main facts of the system have been brought out, and the appearance of the two bodies as viewed from the direction of the earth is shown to scale in the oval diagram. From simple considerations it is established that the companion is about six tenths the diameter of the main body, and the four small circles show the successive positions of the companion in its orbit, which is not circular but slightly elliptical, and of course viewed at an angle. The dotted circles show the position for eclipses, and we find as expected that when the smaller body is behind the primary there is also an eclipse, but in this case only seven per cent of the light of the system is cut off, as compared with eight per cent when the companion is in front. This demonstrates that the smaller body is seven-eighths as intense for the same surface as the main body, and is hence far from being a dark planet.

The figure shows how close together the bodies are as compared with their diameters, and we also find that we are dealing with a giant system. It is very interesting to note the comparative size of the sun, eight hundred and sixty thousand miles in diameter. The larger star of Delta Orionis has fifteen times and the small star nine times the sun's diameter. The system, brought up and placed beside the sun, would not only appear large, but would be extraordinarily intense in comparison, the surface brill-

iancy of each component exceeding the sun at least twenty fold, so that the total light of the system is equal to about five thousand suns! Imagine the conditions of the earth if we had such a pair of bodies to govern us.

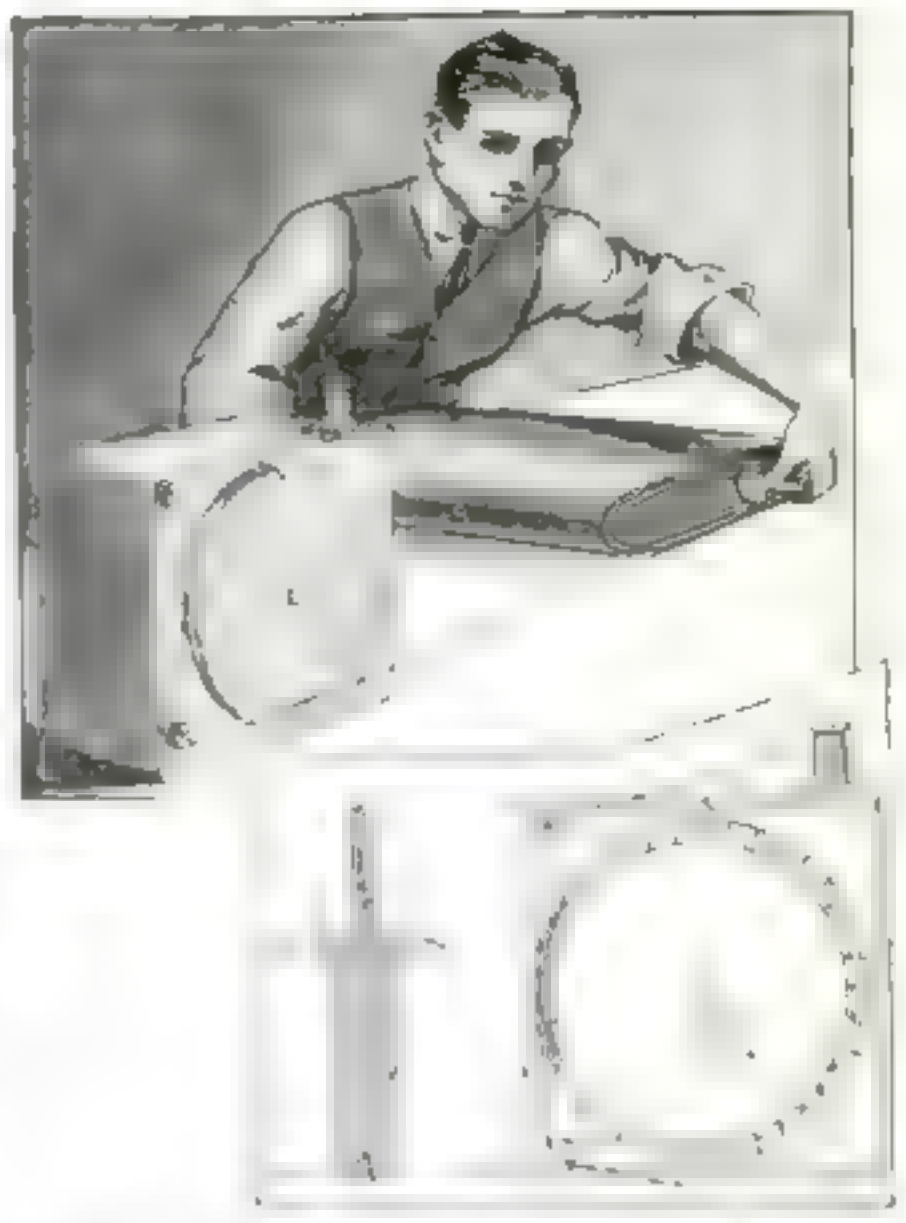
In spite of their enormous size, the bodies are not so very massive, exceeding the sun only about twenty-five times in weight, and therefore they are much less dense than the sun, one hundred and I fty times smaller in density, which amounts to saying that they average about six times as heavy as the same volume of air. According to current theories of the life history of stars, Delta Orionis, like the other objects in Orion, is very young, and in due course of time will contract and cool off and become much more like the sun, though of course remaining more massive.

The case here selected illustrates what can be revealed by electrical measurements of light changes which have entirely escaped eye observation. Many other stars are being studied in the same way, and it is possible to measure their diameters and weigh them, when the only effect at the end of the telescope is a minute electrical current set up by the light action. Thus we see that astronomers are making use of the modern technical advances, and in some cases, like the present, a new device may even be used with success in pure science before it is perfected for commerical purposes.

Measuring Cloth in the Roll

THE inconvenience of unwinding a roll of cloth to measure it has been obviated by a clever mechanism devised by Anthony Fobare. The exact length of any roll of fabric can be ascertained in a few minutes.

The idea consists in passing a thread between the folds of the roll and measuring the thread. For this purpose a tool shown in Fig. 1 is used. The thread passes through a handle 2, which terminates in a projection 3 about the size of a large knitting-needle. A disk 4 is placed between the handle and the projection. When inserting the projection between the folds of cloth this guard presses against the end of the roll, keeping the



Unwinding a roll of cloth is unnecessary to find its length. A thread can be inserted between the folds and the length of the thread taken

projection a uniform distance from the edge.

The spool is mounted on a box 16 (Fig 2) The thread is held under tension by passing between two disks 23 held together by a spring. After passing around a large pulley 39 attached to the side of the box, the thread again passes through two tension-plates 43 and then into the handle of the threading-tool.

The circumference of the pulley 39 is just one yard. On the threaded shaft of this pulley is suspended a traveler or rider 34, which moves along the threads as the pulley is rotated. A pointer 38 indicates the number of turns on a scale 36, placed parallel to the shaft. Every turn stands for one yard. The inches are recorded on the face of the pulley, the circumference of which is divided into thirty-six parts. When the measurement is begun the pointer 42 and the rider 34 should both be at zero. The unwinding of the thread, as it is woven into the roll of fabric, is thus recorded in yards and inches.

This panoramic map showing the entire portion of the world affected by the European conflict, was constructed in a prominent Chicago store as a permanent exhibit

A Marvelous War Map

THE lessons that the war has taught have been many. One of them is that we know less about Europe than we think we do. We are learning geography on a more detailed plan than we did in our school-days. To help us in locating battlegrounds and fortresses the owners of a large and prominent store in Chicago constructed a panoramic map showing the entire portion of the world affected either directly or otherwise by the conflict.

It may be stated that three months' labor by a corps of workers was required to design and construct the war map. The setting has been placed in the playroom of the toy section, and made to resemble a fort, as the view herewith makes plain. The idea was to make possible the instruction of both child and grown-up, and in this way to become a teacher so that the results would be productive of good to the public.

The view shows all the prominent cities in the war section, as well as forts, wireless stations, topography, steamship lines and railroads. It includes such countries as France, England, Germany, Russia, Holland, Roumania, Servia, Bulgaria, Greece, Turkey, Italy, Norway, Denmark, Ireland, Switzerland and Scotland. In each of these countries may be found the important cities and towns, together with churches, theaters, palaces, and other important buildings, all properly located with due regard to distance and other detail. Every body of water is shown. Submarines, warships and other sailing craft sail the oceans and seas. Wireless stations flash their messages, railroad trains race across country, and each city is lighted with its own lamps as well as the lights from other places that make prominent features of the exhibit.

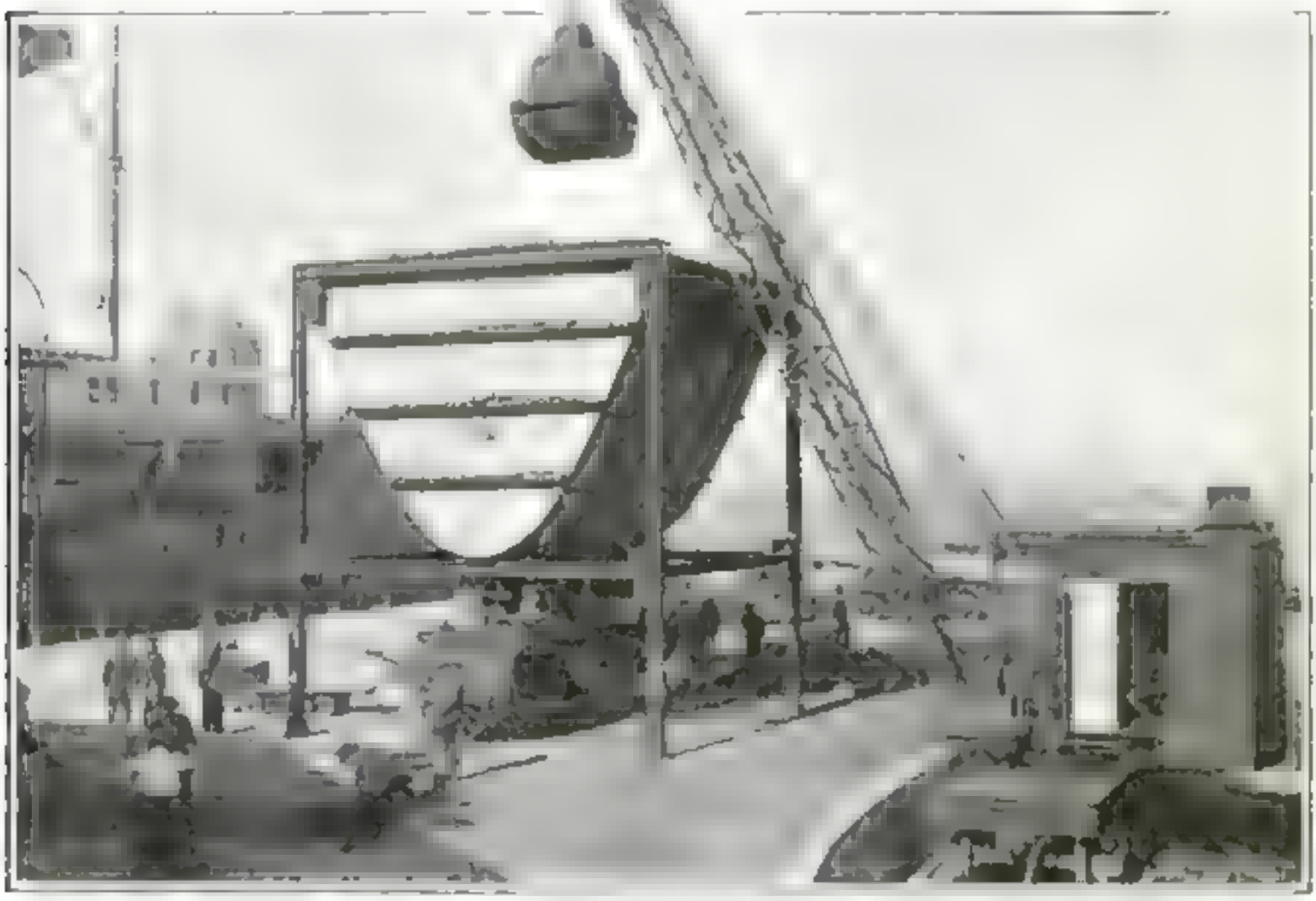
Every ten minutes there is a complete change in the scene, by means of the lighting effects, from daylight to darkness, and the cloud effects and electrical display are wonderful to behold. This is the most fascinating idea in connection with the otherwise wonderful exhibit, and marks a feat that stands out as unique and deserving of favorable comment from all who have witnessed the map. It cost thousands of dollars to construct, and is to be retained as a permanent exhibit.

A Successful Railroad

The best paying railroad in the world, according to length, is the Sandersville road, running from that city to Tennille, Georgia, a distance of three and one-half miles. In 1913 and 1914 a twenty per cent dividend was declared, while in some years forty per cent has been paid on the capital stock. The road's rolling stock consists of two locomotives and two coaches. It makes four round trips daily and hauls practically all the freight coming to Sandersville.

A New Way of Loading Steamers from Freight Cars

AN unusual handling plant designed to reduce the time in transferring pig-iron, coal, steel and various other bulk materials from gondola cars to boats, has been installed by a large steamship company at Cleveland, Ohio.



A gigantic locomotive-crane empties coal into the one-hundred-ton concrete bin from which it is loaded into carts through three hand-operated gates

A one-hundred-ton concrete bin, held above the ground by steel beams, is situated midway between the freight tracks and the steamship. A locomotive crane on the tracks transfers the material from the cars into the bin. Two-ton carts are hauled under the bin, and the coal drops into them through three hand-operated gates. As soon as the carts are filled, they are drawn to the steamship by means of electric trucks equipped with storage batteries. It is said that this plant has proved a decided success and has largely reduced the handling costs of bulk materials.

Bad Roads Make Bad Going

IT is no truer that history repeats itself than that men, in general, do not profit by experience. Writing of the bad condition of the roads in England in 1685, Macaulay says:

"The chief cause which made the fusion of the different elements of society so imperfect was the extreme difficulty which our ancestors found in passing from place to place. . . . In the seventeenth century the inhabitants of London were for almost every practical purpose, farther from Reading than they now are from Edinburgh, and farther from Edinburgh than they now are from Vienna. . . . When Prince George of Denmark visited the stately mansion of Petworth in wet weather, he was six hours going nine miles.

All this was the condition of highway traffic in England two hundred and thirty-one years ago and it can be duplicated in many parts of the United States today. It has been estimated by careful government experts that only about 150,000 miles of really first-rate modern highways are to be found in the United States; the total mileage of public roads in January, 1915, was 2,273,131.

Trench-Digging by Machinery

MODERN engineering requirements coupled with a persistent demand for labor-saving devices have brought into being several types

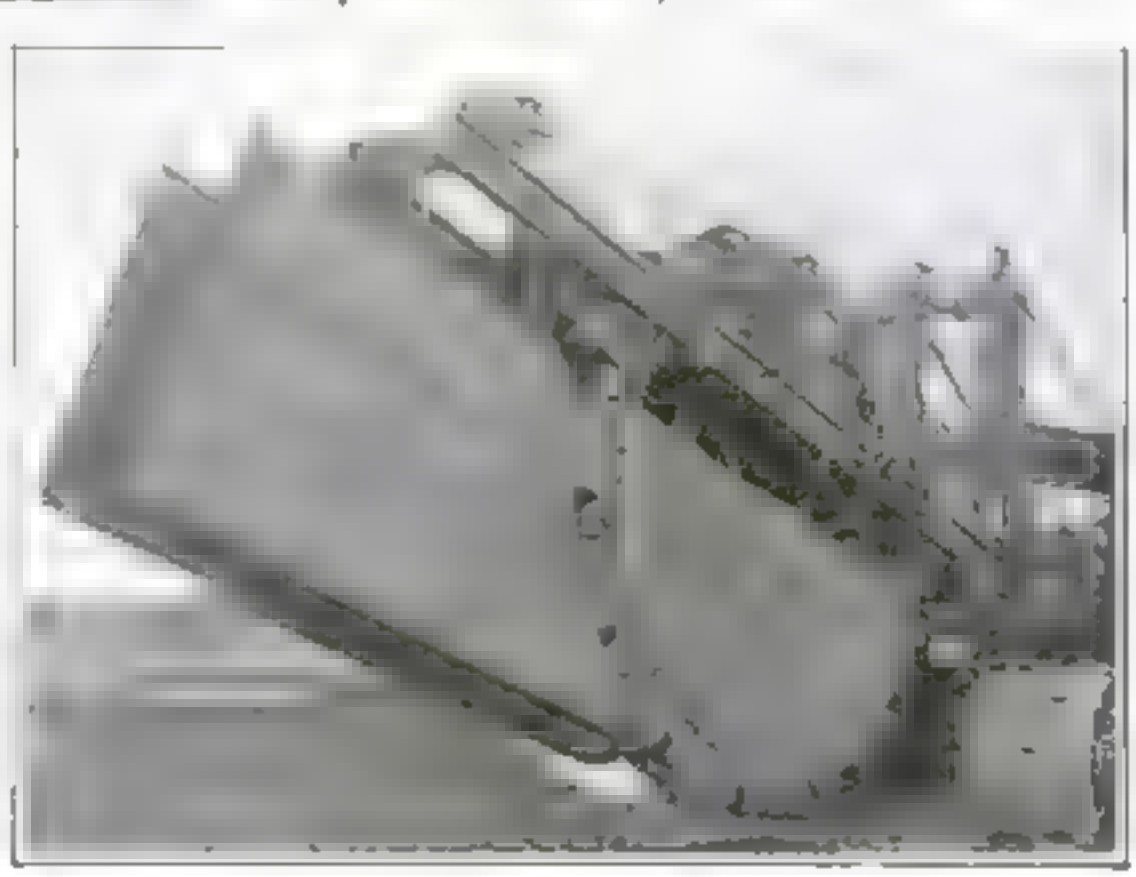
Above, the endless chain type of machine excavating a twelve-foot trench with cutting buckets. To the right, the wheel type of machine with its driving mechanism at the top

of trench-digging apparatus which are of ingenious construction. Of all manual labor, digging trenches by hand or excavating on a large scale by hand is the most laborious and expensive method. One of the largest single items in a contractor's specification, until the modern digging machines came along, concerned the amount of excavating to be done. With the several new types of mechanical excavators this item can be reduced materially.

In the machines recently marketed two general principles seem to be used. In one, cutting buckets are attached to an endless chain, while in the other they are mounted on the periphery of a wheel. In both methods the buckets are forced to bite into the ground at the end of a trench, carrying the dirt up with them as they rise.

The endless chain type of machine grips the dirt and hoists it to the surface in the same way as chain buckets on an elevator-hoist lift grain to upper bins. The wheel type has a curious mechanical feature in that the wheel itself has no central hub. Instead, it consists merely of a rim supported by four sets of rollers mounted on an internal framework. The reason for this is that it gets all the driving machinery up near the top of the wheel, enabling a deeper trench to be dug with a smaller wheel than would otherwise be possible. In fact both types have their driving mechanism located at the upper end of the chain, and both also make use of a transverse conveyor belt to carry the excavated material to wagons as fast as it is brought up.

Behind the wheel on the wheel type of machine is located a bracket-like or L-shaped framework, known as the "shoe."

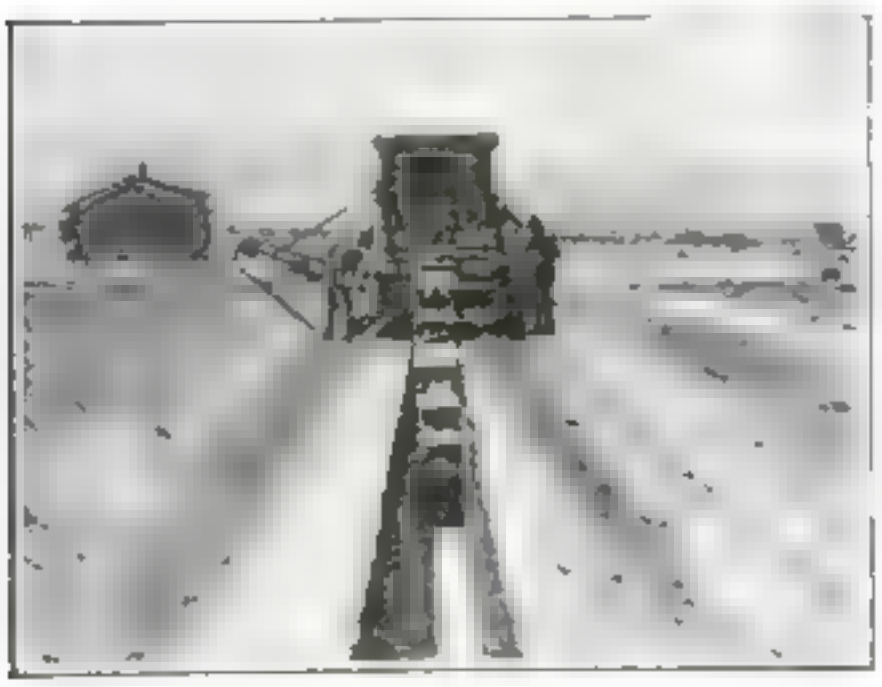


This slides along the bottom of the trench and supports the rear end of the wheel frame work. Depth of digging is controlled by raising or lowering the front end of this framework, the rear portion of course riding along on the "shoe" according to the depth of the front end. A special feature of this "shoe" is that a man can ride on it laying tile or pipe as fast as the digging progresses.

Many widths and depths of trenches can be cut by the machines. Some have been made six feet wide and fifteen feet deep. One machine dug two hundred rods of eleven and one-half inch trench thirty inches deep in a ten-hour day, and another dug a thousand feet of twenty-inch trench five and one-half feet deep in the same time. Small boulders, tree roots, and similar barriers offer no great obstruction, and the machines accomplish work under difficult circumstances with a celerity that is surprising.

"Caterpillar" wheels enable the big machine to travel over soft ground

Various modifications of the chain-type and wheel-type have been made to fit special conditions. These relate largely to the shape of buckets used, since digging an open trench in sandy soil requires a far different kind of bucket than making a clean-cut channel in hard clay. To enable the machines to travel over wet, soft ground "caterpillar" wheels are used.



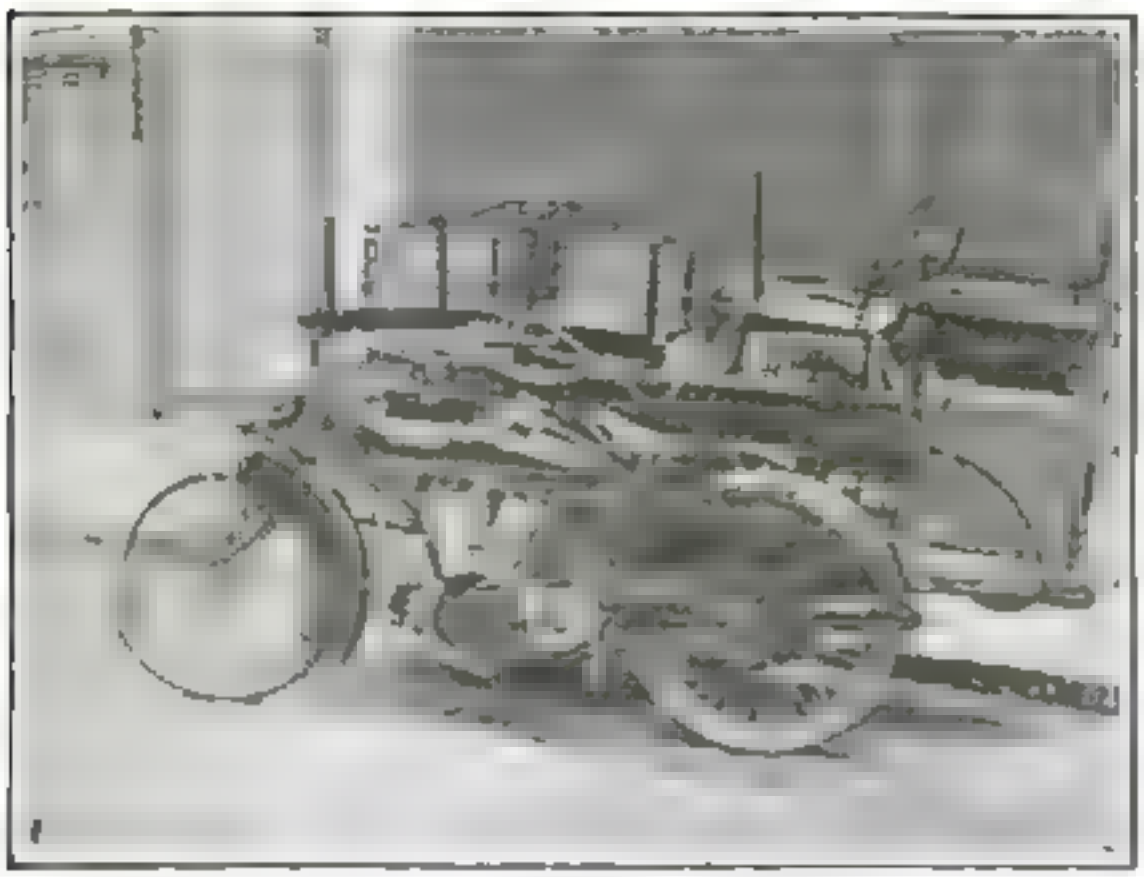
In a ten-hour day this machine will do the work of two hundred men

Traveling by Parcel Post

THOUGH our parcel post is a wonderful system, enabling us to send all kinds of strange things by mail, the English system can do one thing which we have, as yet, not attemped.

An Englishman who was in a hurry to reach a part of London with which he was unfamiliar, called at the general post office to consult a directory. Upon explaining his case, the clerk gave him the startling information that he could go by parcel post for the payment of threepence a mile.

He was accordingly placed in charge of a messenger who took him to his destination. The boy carried a printed slip on which was written "Article required to be delived" with a description of the parcel following.



This motorcycle owner finds it possible to save money by delivering furniture on a side-car chassis

Moving Furniture with a Motorcycle

THE wide range of usefulness of the motorcycle is shown in its utilization for commercial purposes. A furniture dealer in Westerley, Rhode Island, has found that he can make deliveries on a side-car as efficiently and more economically than by the horse and wagon heretofore used.

Upon a side-car chassis, he constructed a small van which can be extended when needed to a length of eight feet. Side boards are added to this, so that a large load of furniture can be carried. The motorcycle in the photograph carries upon its side-car two sofas, one large and one small, one upholstered and one plain rocker and two upholstered straight-back chairs. This load is handled with ease in spite of its bulk and weight.

Locating a Thunderstorm

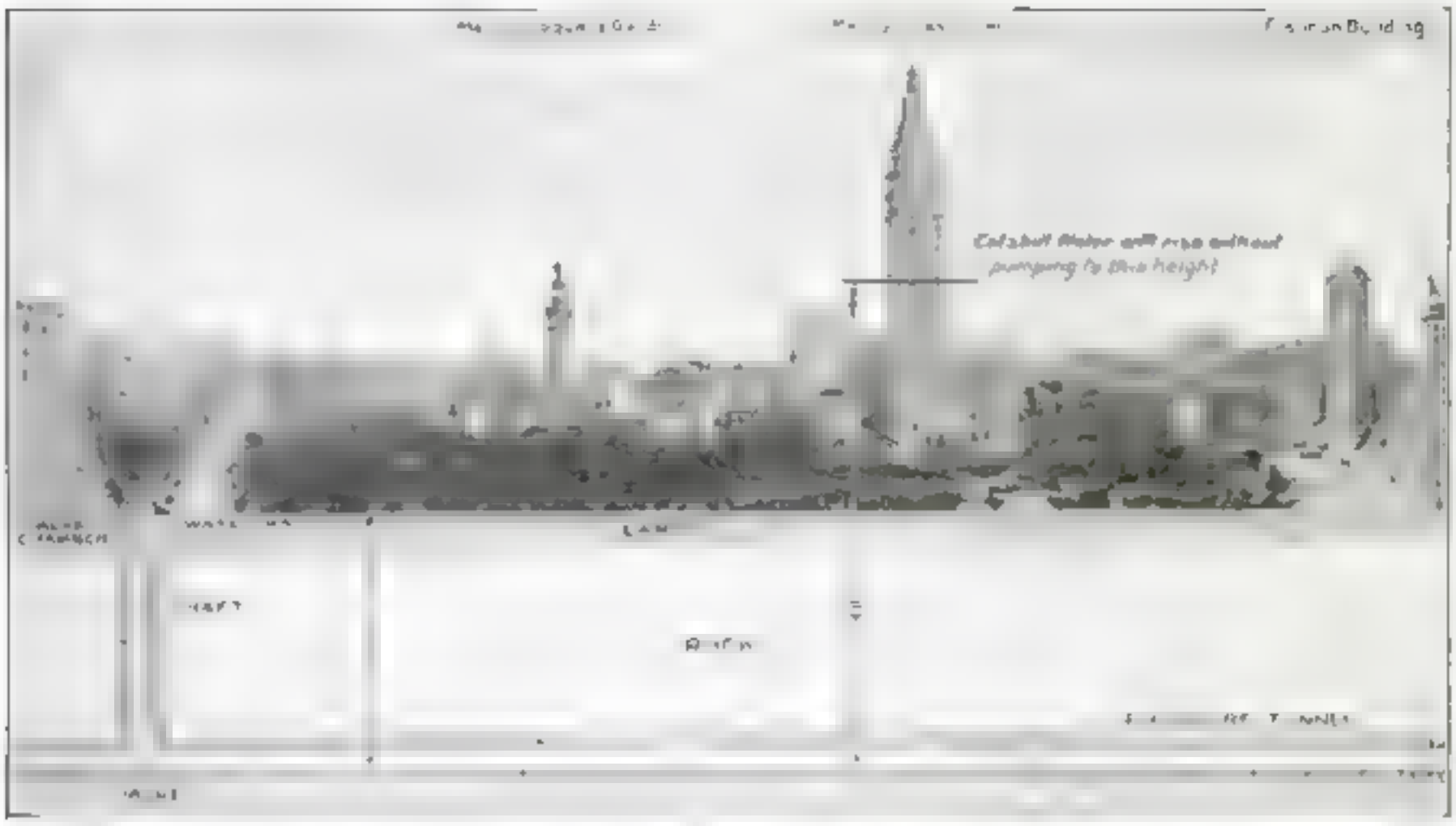
WHEN you see a flash of lightning, count the seconds before it thunders and you can tell how far away the storm is. Since light travels 186,000 miles a second, we may for all practical purposes regard ourselves as seeing the lighting the instant it flashes. But sound travels only 1087 feet a second. Multiply 1087 by the number of seconds during the interval between the flash and the thunder and the result is the distance between you and the storm. As a rule, from twelve to fifteen miles is the greatest distance thunder can be heard.

Stores on Wheels

A DAYTON woman who conducts a tobacco and confectionery shop has instituted a system of traveling stores that has served to increase her business to an appreciable extent. The traveling stores are in charge of small boys, but they are so arranged that the business is carried on in a systematic manner.

Each store is a wagon—a two-wheeled cart to be exact—and the goods are protected from the elements and the dust by glass covers. The carts are, in fact, traveling show-cases, and a full assortment of goods is carried at all times. An interesting and business-like feature is the special compartment for a cash register, which makes the outfit complete.

An enterprising woman has been able to increase her business by bringing her wares to the customer



Water supplied to the city of New York from the Catskills rises two hundred and eighty five feet under its own pressure

Water Rises to Three Hundred Feet in New York Sky Scrapers

A CITY possessing a pressure system capable of elevating water a vertical distance of nearly three hundred feet above street level without pumping is unusual. Yet New York's new Catskill supply system will accomplish this feat. Contrasted with the thirty or forty-foot heights which the average city system can attain, the performance is out of the ordinary, to say the least.

The artificial lakes supplying the water to New York are high up among the Catskill mountains, one hundred to one hundred and twenty-five miles north. In the case of the Metropolitan tower, for instance, this height to the supply enables the water to rise unaided two hundred and eighty-five feet above the ground level, or four hundred and eighty-five feet above the pressure mains, which are themselves two hundred feet below the street surface. The two hundred and eighty-five feet are more than two-thirds of the way up the occupied portion of the tower, so that but comparatively little pumping is necessary in order to reach the highest offices. The case is typical of all the large buildings in the city.

Heads such as that mentioned mean that pressures over two hundred pounds to the square inch have to be contended with in the huge mains so far below the surface. This condition necessitates unusual construction. In fact, the whole length of the mains from the Catskills to the city is made up of difficult engineering feats. Over much of the distance they are made of steel tubing, lined and re-enforced with concrete. In places they bore through solid-rock mountains, tunnel under rivers and lakes, burrow far beneath city streets and skyscrapers, all that the city may be reached by the shortest route consistent with engineering economy. Smaller mains near the surface care for the work of local distribution.

War and Trade

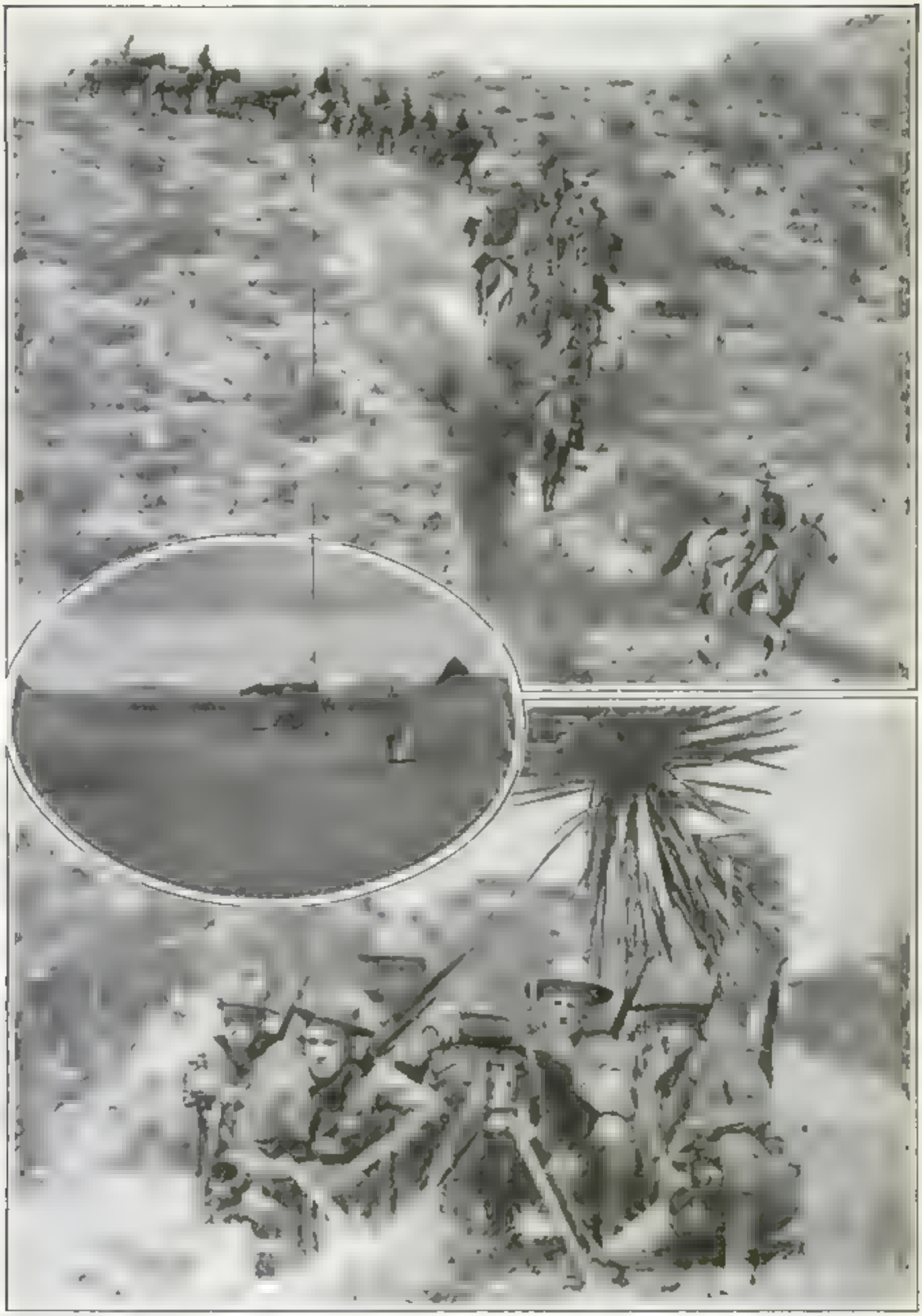
BECAUSE many foreign-owned vessels, which formerly traded between the United States and South American ports, have been withdrawn for war purposes, trade is thereby increased in proportion for American vessels. It is estimated that seventy per cent of our commerce with Brazil, the Argentine and other South American countries is now being carried under the American, Brazilian and Argentine flags. Of the remaining thirty per cent only about fifteen per cent is still carried in vessels of the nations at war.

What a Lot of Machinery to Chase Villa!

Above, a few United States trucks in the Mexican expedition. At left, water supply wagons

Above, one of our flying squadron of aeroplanes which started bravely after Villa and his fleeing band. A few days after the pursuit began, two aeroplanes were in condition

The Sixth Infantry encamped on the line of communication between the cavalry at Villa's heels and the base of supplies. One of these small tents is carried by each soldier, and is used only to give him shelter while resting



At top, the Seventh Cavalry machine gun troop crossing the divide south of Casas Grandes In oval the army wireless station at Columbus, New Mexico Above the Eighth Cavalry machine gun troop in practice Many of our guns are obsolete in design, in the recent raid one gun became clogged and had to be abandoned

We Wonder If Villa Has These Conveniences

Above ambulance corps leaving Columbus, N. M. for the interior. At left, the "rookies" at Camp Cotton, El Paso, being whipped into shape for possible service in the future. Infantry men are shown going through skirmish drill

The cook preparing dinner for his waiting, hungry company He is cutting bacon, the one staple product of the West obtainable in a sufficient quantity for the soldiers. Bacon and canned tomatoes—the latter because of the liquid—are the two table necessities of those who live in a country so dry that to waste a pint of water is to court the undertaker. Great difficulty has been experienced in the Mexican campaign because of the high winds which lash the sand and dust violently against man and beast. It is impossible to move in any one direction in a sand-storm. To prepare food under such conditions requires all the patience and fortitude that soldiers are credited with having

Our Punitive Expedition Into Mexico

© Underwood and Underwood, N. Y.

Caught between the roving bands of marauding guerillas, Mexican families have suffered terrible hardships during the past three years. In some instances the homes of peaceful people were destroyed and the members murdered without any reason other than the satisfaction of some alleged leader's lust for blood. Siding with Villa or Carranza was useless to ward off these plundering bandits, seeking to destroy both life and property. The photograph shows a band of Mexicans making their way to the United States, where they can set up house and be safe under the Stars and Stripes. Many American families have also been obliged to leave homes and industrial interests, and seek refuge on our own soil to escape the depredations of Mexican outlaws

Mexican weapons captured by Americans. The lifting of the embargo on arms has placed within the convenient reach of every cut throat in Mexico weapons of the most modern type; in fact, weapons of the same effectiveness as those used against them by the United States troops. Mexico has suffered shortage of everything except arms and ammunition during her recent state of internal revolution. At right, troops of the Punitive Expedition drawing water from an improvised well near Divisional Headquarters at Casas Grandes, Mexico

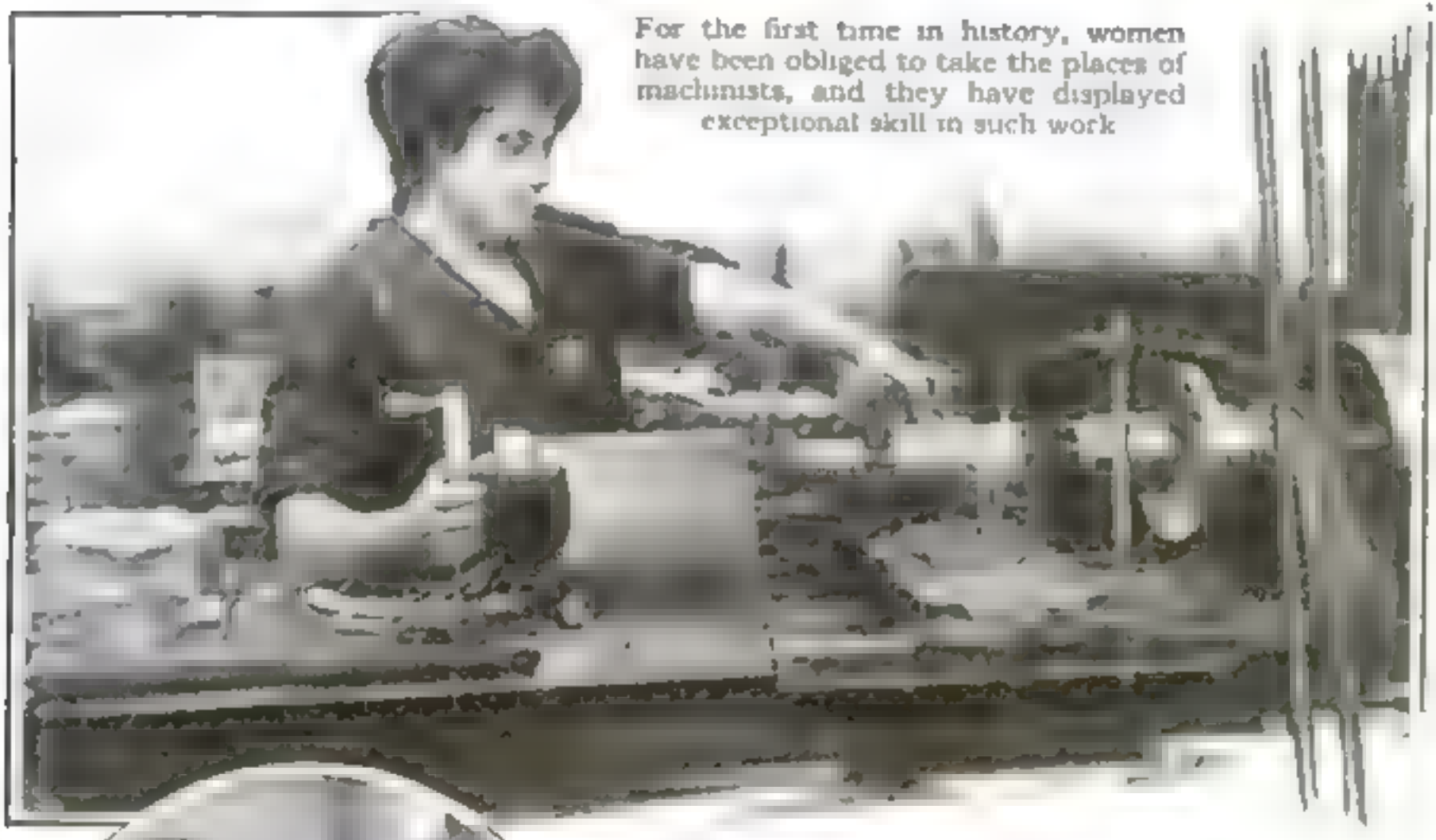
Some of the huge baskets in which provisions and munitions are shipped to the Russian Army on the firing line

Above, an unusual test, even for a dispatch bearer's motorcycle. Some of the most notable feats of the war have been accomplished by sturdy motorcycles, but most machines "in Active Service" have a short life

Even menagerie elephants have to do their bit for England. In the streets of Manchester this great tireless beast hauls heavy drays

Does This Mark the Beginning of a New Labor Era?

A three-inch shrapnel shell contains approximately two hundred to three hundred bullets, each one-half an inch in diameter. A matrix of resin or other smoke-producing substance keeps the bullets from rattling, and determines the location and time of explosion by creating a black smoke. At the right, French women loading shells. A small car with receptacles for the shells is run along between the work tables to receive the shells when prepared



For the first time in history, women have been obliged to take the places of machinists, and they have displayed exceptional skill in such work

Above, tamping down explosive charge with cork stopper. At right, adjusting "safety-heads" to prevent premature explosion of the charge

British riders taking wounded soldiers for an outing. Thousands of convalescents are thus given their airing every week. In the upper lefthand corner anti-aircraft practice

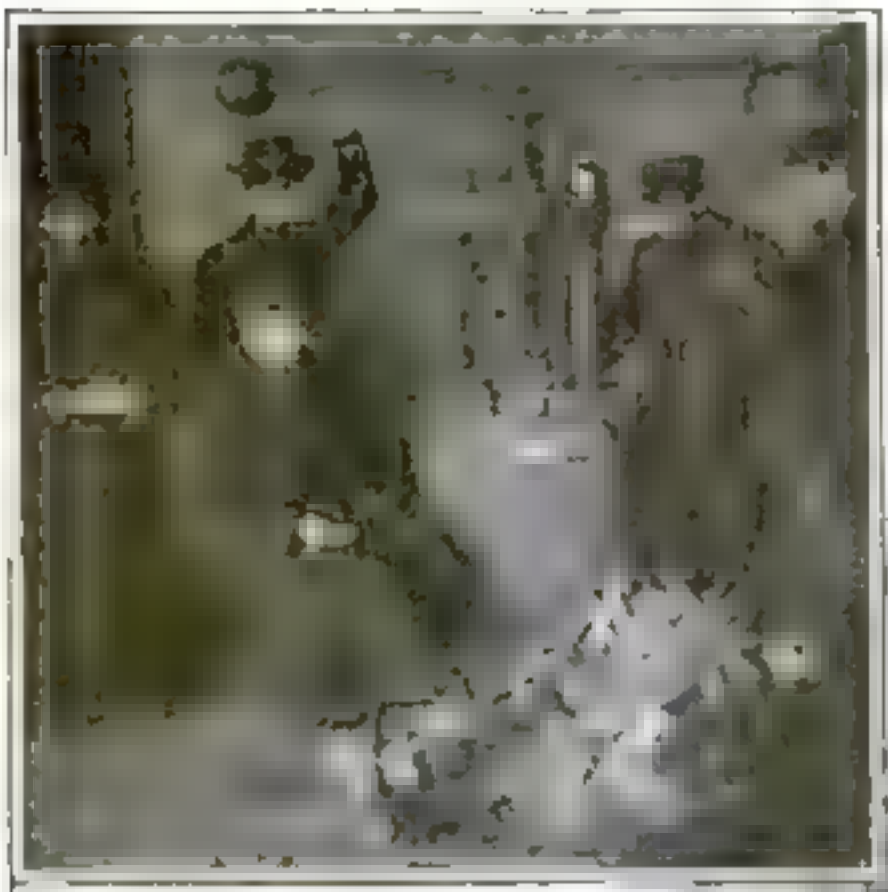
Two of the principal uses of the motor-cycle on the war front are carrying dispatch riders at terrific speed from one part of the line to another, and making forays while mounted with light machine guns. Six or eight of these fragile looking motor-cycles make a formidable battery, and even the most reckless opponent might well hesitate to attack them.

Snorting Horse But on a Swift Motor-Cycle

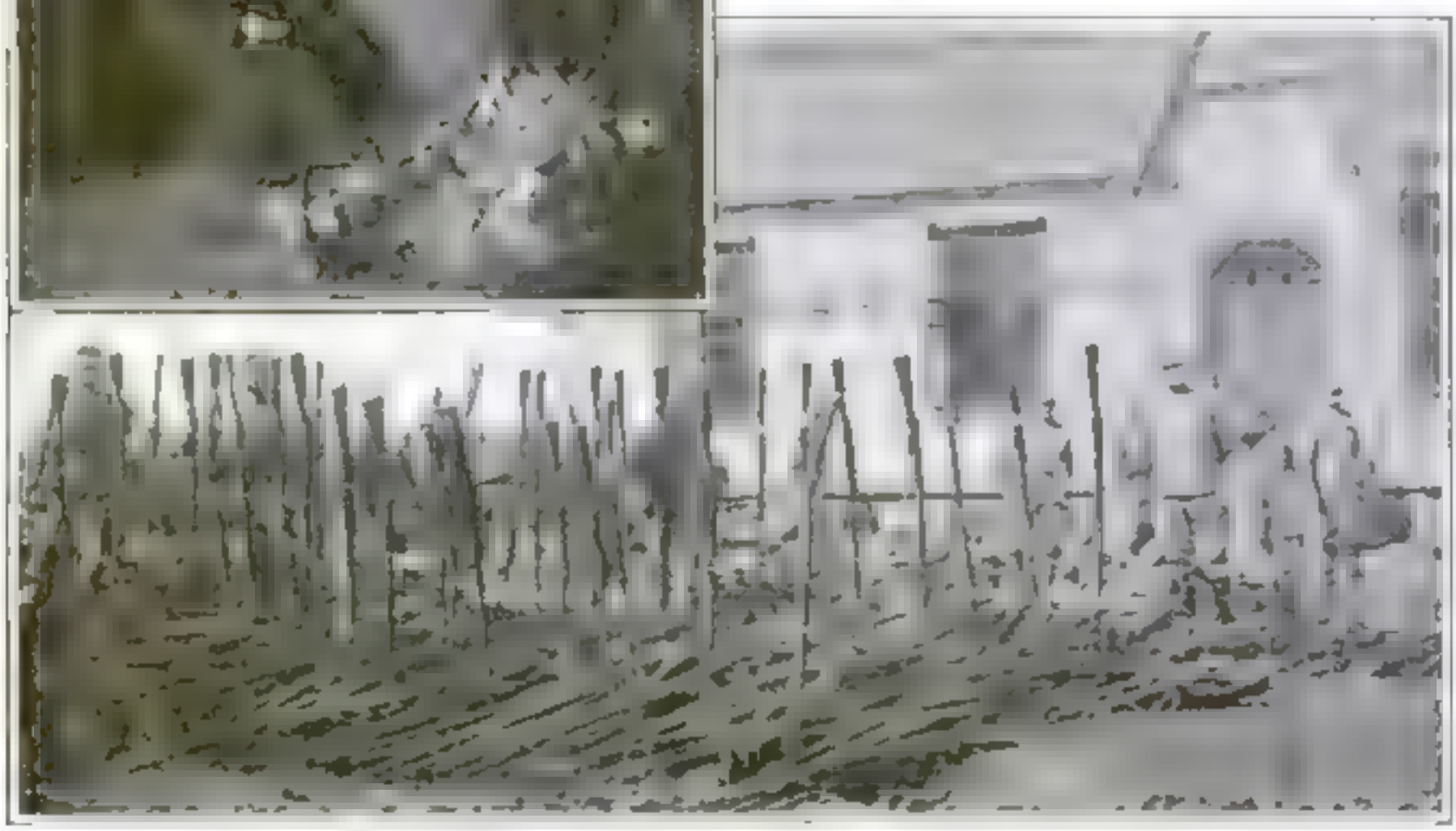
At top, a motor-cycle trailing a prairie schooner with accomodations for four In the circle and oval, a motor cycle bearing a small machine gun — the design of Sergeant Leonard (U S. A.)

A few more glimpses of the daring motor-cyclists with the British Expeditionary force. Owing to the great speed of these machines, they are often detailed to the most dangerous work, and many coveted medals have been presented to the riders

Nothing Is Unusual in Europe Now



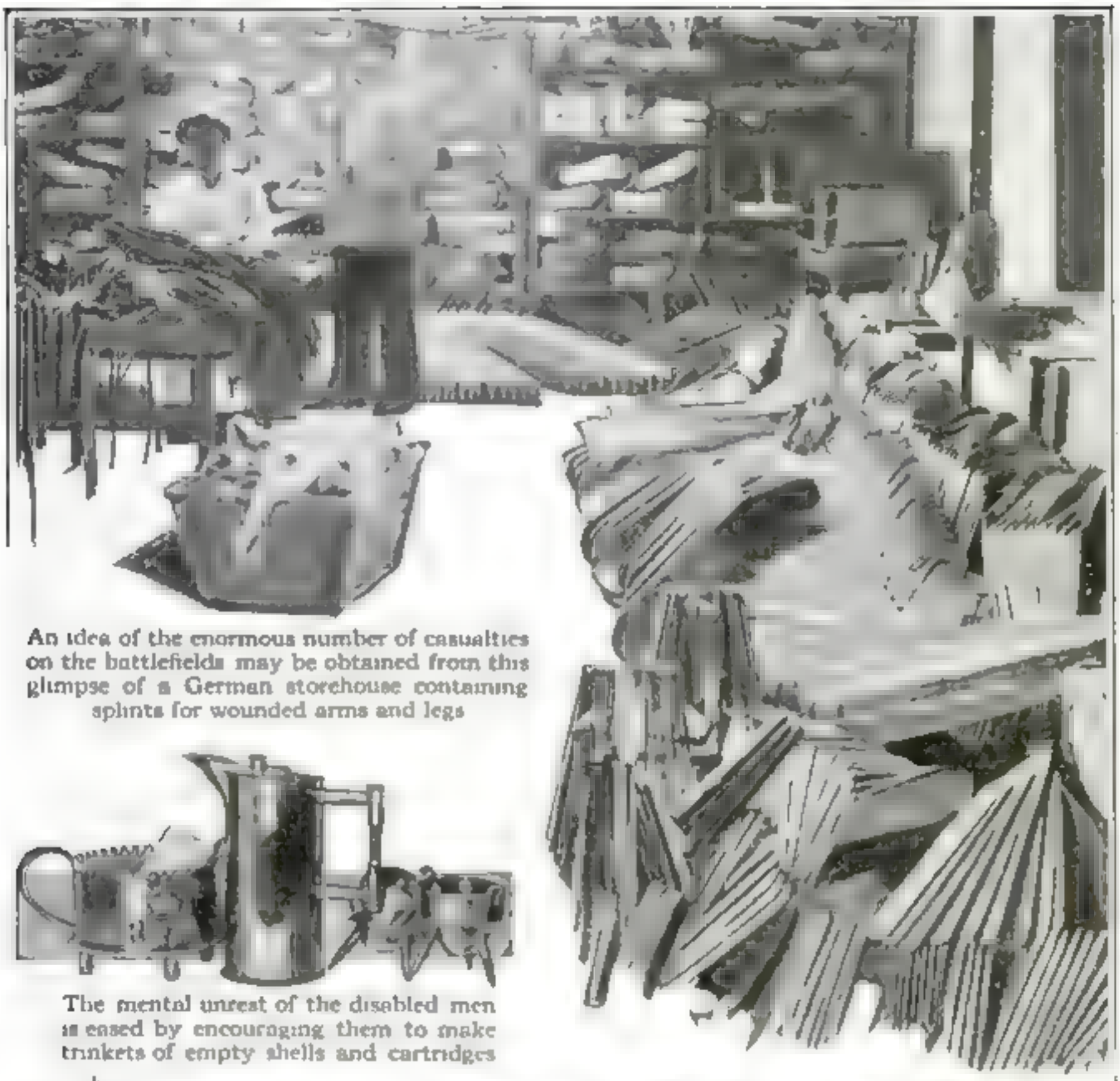
Russia like every other seemingly civilized country harbors its money counterfeiters. The United States is, however, comparatively free from counterfeiters compared with foreign countries. In Russia and Italy the destruction of counterfeiting "plants" is an everyday occurrence. The photograph shows a group of Russian counterfeiters gathered about their press and dies. Note the crude type of machine employed in this illegal industry



A wholesale capture of Russian firearms by Austria—the work of one day's fighting

British troops which are being retained in England awaiting the call to the front while away their time by making a huge war map of Europe with cobblestones

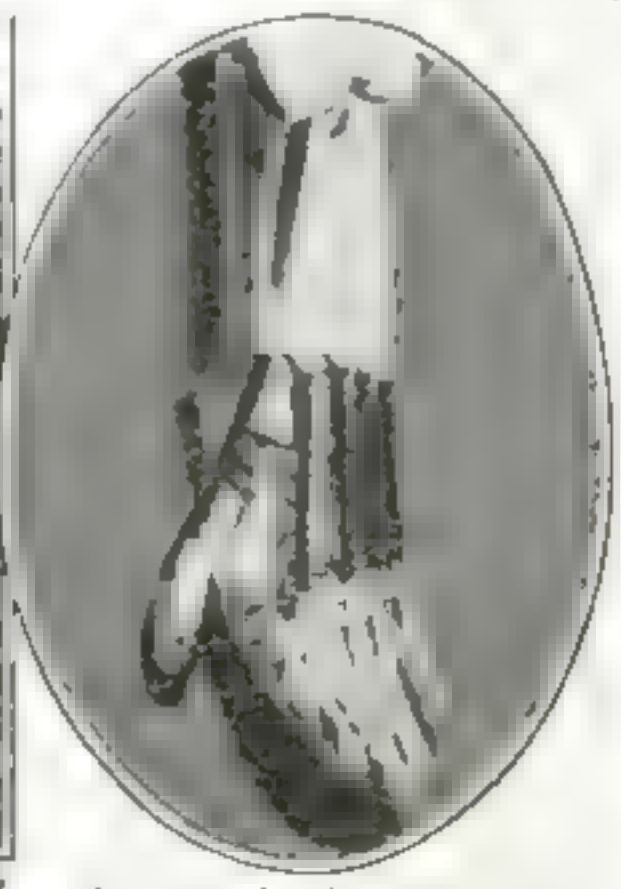
Repairing the Human Wrecks of War



An idea of the enormous number of casualties on the battlefields may be obtained from this glimpse of a German storehouse containing splints for wounded arms and legs

The mental unrest of the disabled men is eased by encouraging them to make trinkets of empty shells and cartridges

An artificial sunbath of ultra-violet rays which is being used by a German military hospital for healing

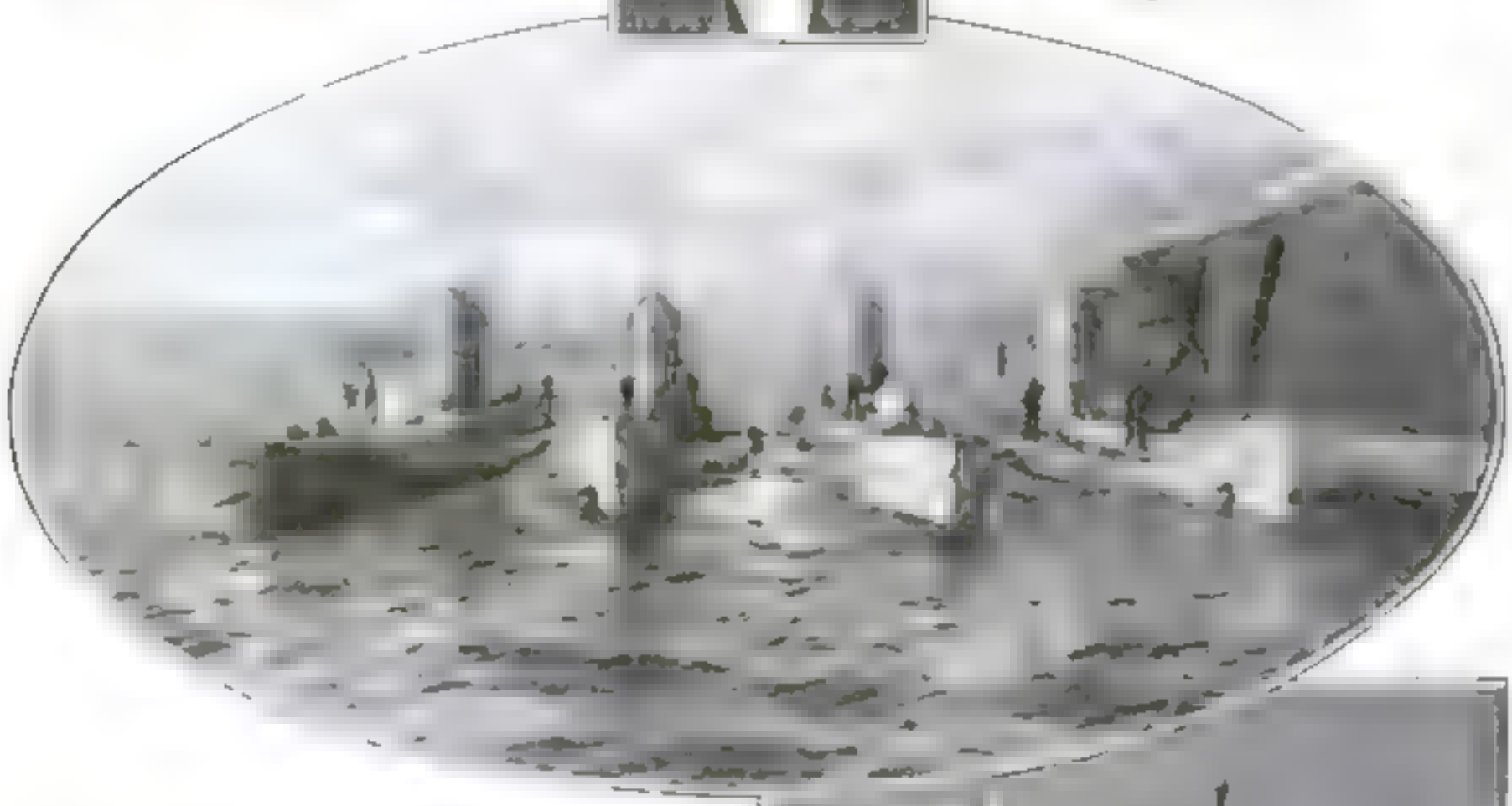


A repair for frozen fingers—a glove with elastic bands which stretches the fingers and thus hastens the cure

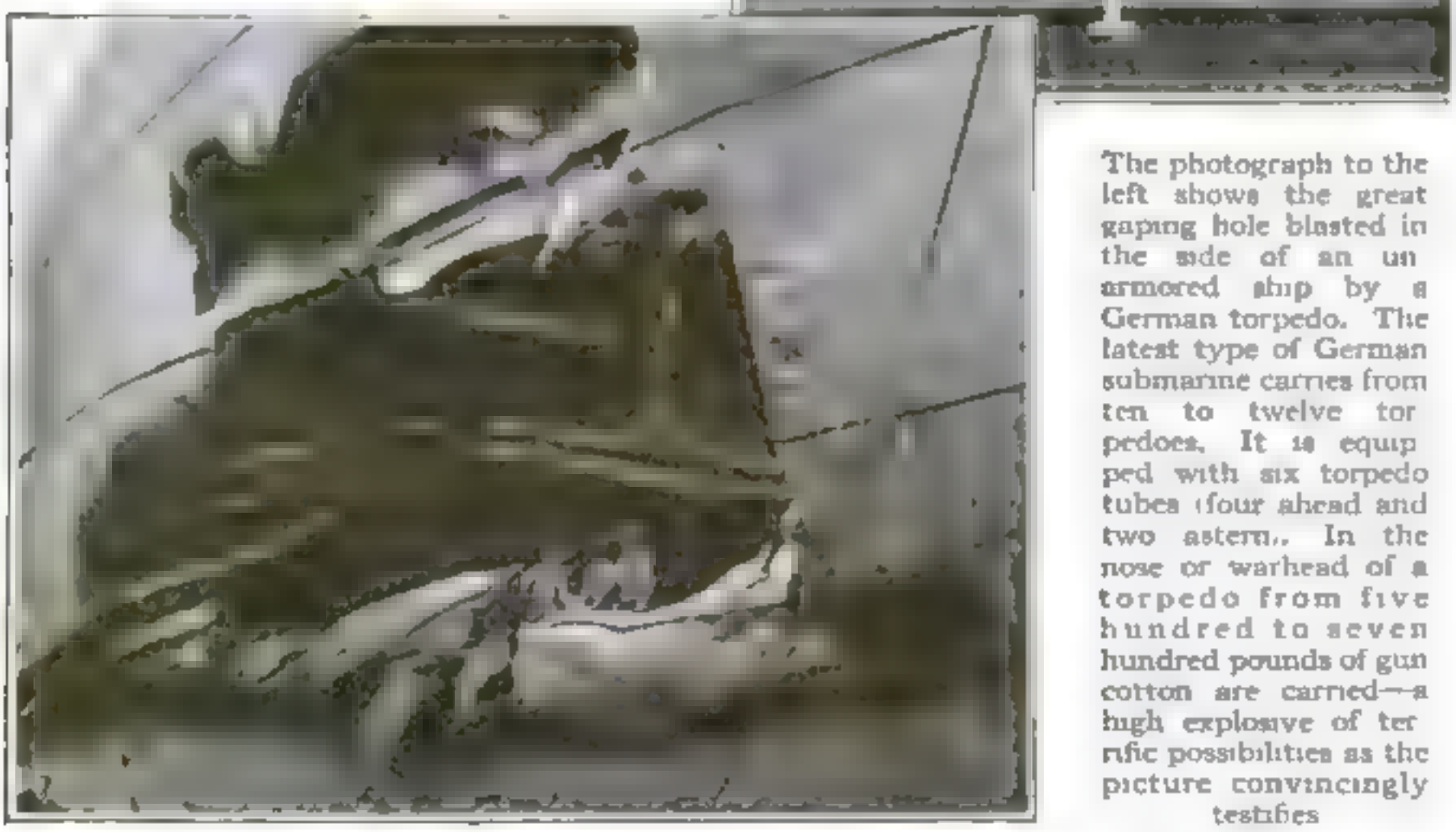
Like Other Countries Germany Did Not

Although Bushnell and Fulton had both demonstrated the practicability of navigating a vessel under water, Germans took but little interest in the subject until 1850. In that year Wilhelm Bauer, whose portrait appears to the right, built the U boat illustrated Bauer served as a Bavarian artillery officer in the Danish

War and had ample opportunity to note the havoc wrought by Danish warships on Schleswig Holstein troops. He thought it would be easy to build a submarine boat which would destroy the Danish warships. The Prussian government was not very encouraging, and so he had to build his vessel with the aid of private citizens

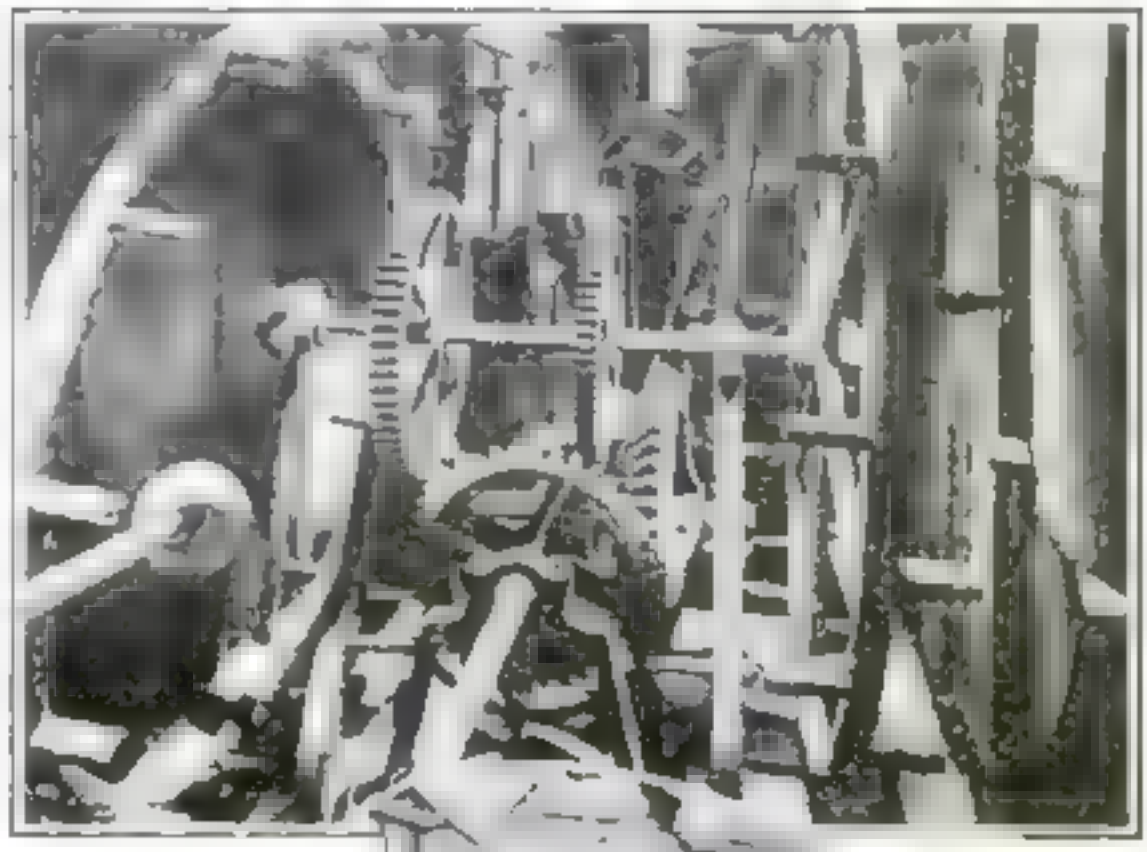


In the oval, a squadron of German submarines. Two types of submarines have been developed, known in this country, respectively as the Holland and the Lake types. Americans are prone to regard Holland as the pioneer submarine inventor



The photograph to the left shows the great gaping hole blasted in the side of an unarmored ship by a German torpedo. The latest type of German submarine carries from ten to twelve torpedoes. It is equipped with six torpedo tubes (four ahead and two astern). In the nose or warhead of a torpedo from five hundred to seven hundred pounds of gun cotton are carried—a high explosive of terrific possibilities as the picture convincingly testifies

Take Kindly to Its First Submarine



The two photographs to the right show respectively the internal operating mechanism and the exterior of Bauer's ill-fated submarine. The boat was propelled by means of pedals and a train of gear wheels and cog wheels. The "Brandtaucher," (Fire Diver) as Bauer's boat was called, made just one trip in Kiel harbor. That was in 1851. The boat foundered, but fortunately the crew was rescued. The vessel was not strong enough to stand the pressure of water when submerged. In 1887, thirty-six years later, the government undertook some dredging in Kiel harbor for the purpose of building a torpedo basin. Bauer's submarine was then discovered, raised and transferred to the courtyard of the Berlin Naval Museum, where it may now be seen. The submarine is a product of many lands and many minds. Even in ancient times efforts were made to navigate vessels under water—apparently with little success. Napoleon gave the subject some thought. It was with him that Robert Fulton dealt The submarine, as we see it, combines the ideas of Bushnell, Fulton, Nordenfeldt, Holland and Lake

To the left, a German submarine of an early type shown in section. Below, a German submarine of a late type. These late submarines have a radius of action of about 2,000 miles; that is, after having filled their oil tanks they can travel for that distance before it becomes necessary to replenish their fuel supply

French Life Along the Western Battle Front

At left, French grenadiers. With their shields and metal helmets they look for all the world like Middle Age soldiers. Below, an improvised officers' quarters. At lower left hand, a legging impervious to barbed wire, invented by George Lynch, the war correspondent. At lower right hand, a Scottish Highlander

At top, a German dépot of telephone materials containing a vast amount of wire and other devices for the prompt installation of an efficient telephone system. The telephone, more than any other single factor, has made trench warfare possible. The illustration shows Vedrines, the famous aviator in his Morane monoplane. The gun shoots straight ahead, and bullets which happen to hit the rapidly revolving propeller are deflected

Making and Using the Booming Guns

Above, French gun carriages being tested at the Creusot works. At left, an Austrian mortar at maximum elevation. Below, a 220-millimeter 8 8 inch) gun

The Italian engineers have proved themselves among the best in the world. Time and again the Austrians have been surprised by having shells dropped upon them, apparently from the skies. The Italians had dragged huge guns up precipitous mountain slopes and were safely installed out of the enemy's range on plateaus, from which shells were fired over mountains. Here we see a 305-millimeter gun (12-inch) being assembled on a mountainside

How a Zeppelin Raider Appears to Englishmen

A target for hundreds of British anti-aircraft guns. This remarkable photograph was taken as a marauding Zeppelin, on a bomb-dropping raid, passed a quiet East Coast town on its way to lightless London

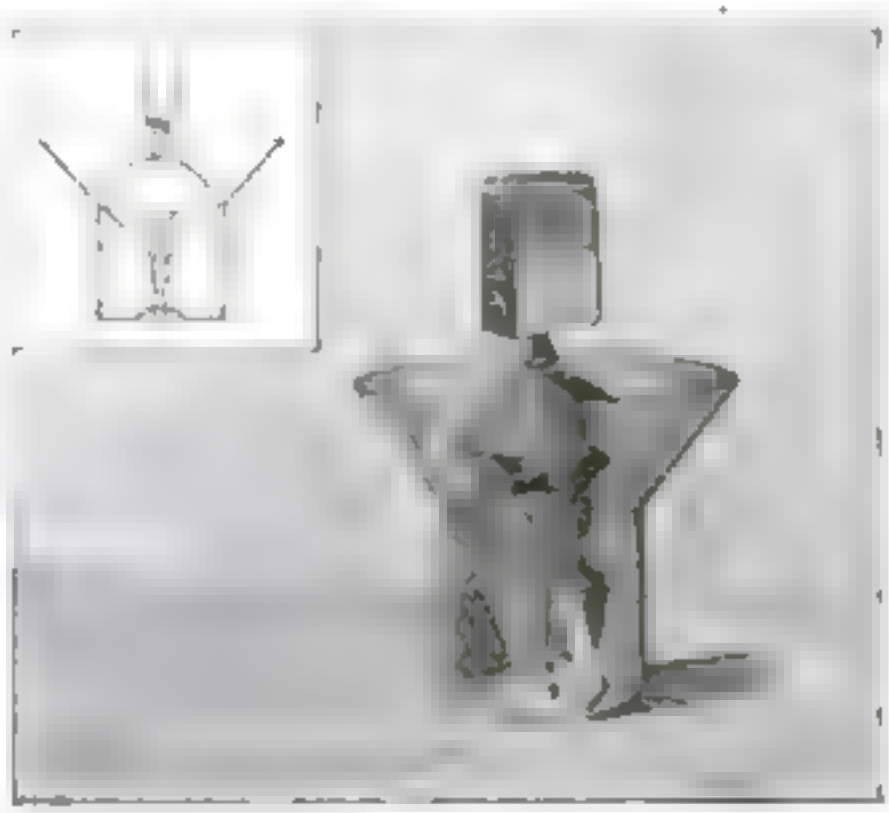
Straw Hat Insurance

NO longer need we fear the elements when we essay forth in our new straw hats. Come dust or rain — our protection is ample.

The invention that calls forth this outburst of enthusiasm is a light hatshield, printed in imitation of the kind of hat it covers —supported by an ingenious frame and fastened in place by tension clips. That it may always be at hand in case of need, it is kept folded inside the crown.

Fooling the Pickpocket

NO one can open the bag shown in the illustration without being detected, whether it is being carried or not. A small battery 2 is connected with a bell 3, which is connected with a metal plate 4, located near, but not touching another plate 5. Connected with plate 5 is one of two bars, 6 and 7, placed the one above and the other below the handle of the bag. The other bar is connected with the battery, a small switch being inserted between them for breaking the circuit when desired. Situated close to the two plates 4 and 5 and actuated by one of the hinged mouth-bars of the satchel is a switch or contact-bar 8. When the bag is opened, this bar touches both plates and thus completes the circuit, ringing the bell, and warning the owner.



A Buzz-Saw Safety Razor

RAZORS have been further improved by means of a device for rotating a safety blade. A small motor 3 is encased within an insulated handle. Small gear-wheels, 6 and 7, transfer the power to a revolving shaft 5, to which is attached a razor-blade 4. The electric current is carried to the motor by means of a cord 1, which passes through the handle, as shown in the diagram. The lever 2 serves for turning on the current. In operation the blade moves close to the opening 8.

A Tray to Hide Unsightly Cigar Ashes

AN ash-tray which eliminates the unsightly appearance of cigarette stubs and the fumes they give off, is shown in the illustration. A funnel-shaped part has its lower opening attached to the upper rim of a cylindrical box. Resting in the funnel is another member, consisting of two cones with their bases together. At their widest part, they rest on the funnel at its junction with the box. A ring-shaped trough is thus formed, into which ashes may be deposited. The cone is supported by a vertical pin attached to the base of the box. By lifting the cone, the ashes fall in the box. The ill-smelling fumes, however, are prevented from escaping.

These Desert Mates Never Quarrel

OVER one of the trails of the Sahara Desert the queerest of teams is employed in drawing a two-wheeled cart, which carries light freight. The team consists of a camel and a small mule, and while the loads may be unevenly distributed between them, the mates never disagree. Naturally, they are rarely in step. Each draws his portion of the load in his pecu'iar way, the camel loping along with great strides while the mule trots—almost scampers—beside him.

The widely differing peculiarities of a mule and a camel are here combined to form a curious team

This Gold Dredge Is a Glutton

FROM the farm lands of Ohio has come an application for patent to Washington—and it has been granted—upon a placer-mining dredge which can wash and extract the gold from six hundred to twelve hundred cubic yards of ore dirt in a day. Moreover, an active application of the principle contained in the patent is doing its work daily in the placer fields of Colorado.

The action of the mining machine is not entirely unlike the well-known gold-dredge, or "gold hog," as it is familiarly called in California and Alaska. This machine, however, runs on tracks instead of in the water and shovels the dirt from behind instead of from in front. A capable steam dredge digs up the pay dirt, swings it above the separating machinery and drops it into a hopper. Water is sprayed on the incoming dirt at the rate of two thousand gallons a minute. The loosened ore then undergoes amalgamation (dissolving in mercury), the precious mass dropping below the hopper into a tank in which it is heated, the mercury being vaporized and re-condensed, and the gold accumulating in the tank.

The dredge gulps from six to twelve hundred cubic yards of gold-laden dirt every day

Two New Colossal Bridges

NOTABLE among the great engineering feats of the year 1915, are the colossal bridges which were constructed. As successor to the unfinished structure over the St. Lawrence at Quebec, which collapsed a few years ago, a new bridge, the longest arch in the world, is being completed. Its span is 1800 ft. During six months of last year about 32,000 tons of steel were placed in this bridge.

The beautiful arch over Hell Gate, 977 ft. long, is of massive construction for carrying great weight.

A Device for Numbering Photographic Plates and Films

A PLATE and film-numbering machine invented by John R. Stephenson of Pullman, Washington, makes it possible for the photographer, professional or amateur, to keep an accurate record of his photographic plates and films. In operation and appearance the machine resembles a small adding machine. It prints any desired number on the light-sensitive surface of the plate or film (which after development is termed a negative) by the transmission of light through transparent figures arranged on opaque numbering strips. These strips bear the numbers 1—9 consecutively and 0.

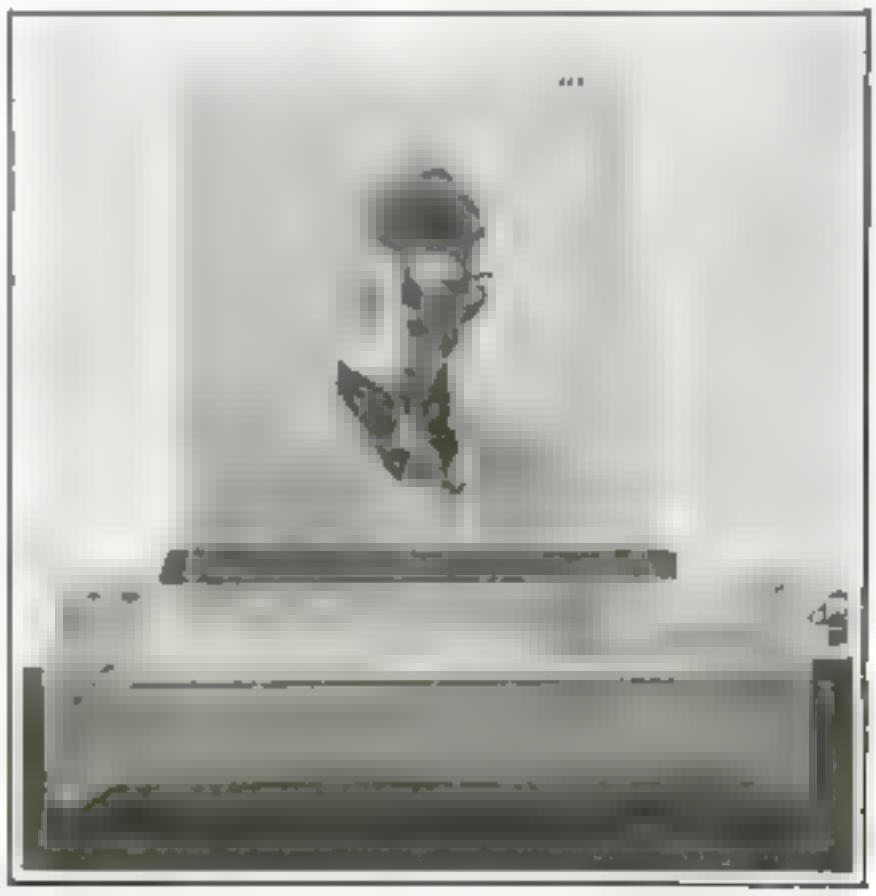
This simple device, resembling in appearance a small adding machine, enables the photographer, professional or amateur, to preserve an accurate record of his photographic plates and films

The machine has a slot in which the point of a pencil may be pressed and the strip slid along in its groove in the numbering machine until the desired figure is positioned over the opening in the table member of the machine, through which the light passes to print the numeral on a photographic plate or film, resting on the table of the machine. The rays from an electric flashlight under the table member are reflected by a slanting mirror up through the opening and through the figures on the numbering strips of the machine, to transfer the numbers to the photographic plate or film.

Guide pieces on the table member hold the photographic plate in the proper position over the numbering machine. This makes it easy to operate in the dark, as it furnishes its own light for handling and the guide pieces insure proper positioning of the photographic plate or film to be numbered. It is possible to print the photographs either in white or in black. If transparent numbering strips having opaque figures are employed, small opaque surfaces, with transparent numerals appearing therein will be plainly legible when the dry plate or film is developed. If opaque numbering strips having transparent numerals are employed, opaque figures will be printed.

Submitting Photographs for the London Exhibition

THE sixty-first annual exhibition of the Royal Photographic Society will be held as usual in August and September of this year. Mr. C. E. K. Mees of the Eastman Kodak Company has been appointed one of the judges in the scientific section of the exhibition and he will receive photographs from exhibitors.



Transparent numerals on a small opaque area or opaque numerals can be transferred to each negative

Why Does a Rifle Crack?

By Edward C. Crossman

A WAR strength infantry company lay in our rear. We walked toward its far-off target, nearly in the line the bullets would take, a few yards' divergence to the left giving us the safety margin we felt would be enough with such expert marksmen. From some indefinite point in the air to our right, there came a sudden burst of high, thin, eerie crashes, the thin crash that comes from the leap of the electric spark from the static machine, repeated in fitful fashion. Most extraordinarily, the sound lacked any definite point of origin; it seemed higher than we were; and it seemed to come from our right. Nearer than this we could not locate it. A slight lull in the sharp crackling, and there came another sound—the heavy, dull thudding of guns fired at a great distance. As we progressed toward the long fire target twelve hundred yards from the infantry, the queer crackling noise followed us, growing thinner and more weird, but the thudding of the far distant guns grew fainter.

Photograph by Ordnance Department, U. S. N

This picture was taken when the bullet was eight inches from the muzzle, and traveling at a speed of roughly a half-mile a second. The two wires making the contact and the electric flash by which the photographs were made are shown as two black lines. The bullet takes its own picture. Note the eddying effect of the air behind the bullet. The fastest mechanical shutter, giving an exposure of one-thousandth of a second, would allow the bullet to move 2.7 feet during the opening of the lens

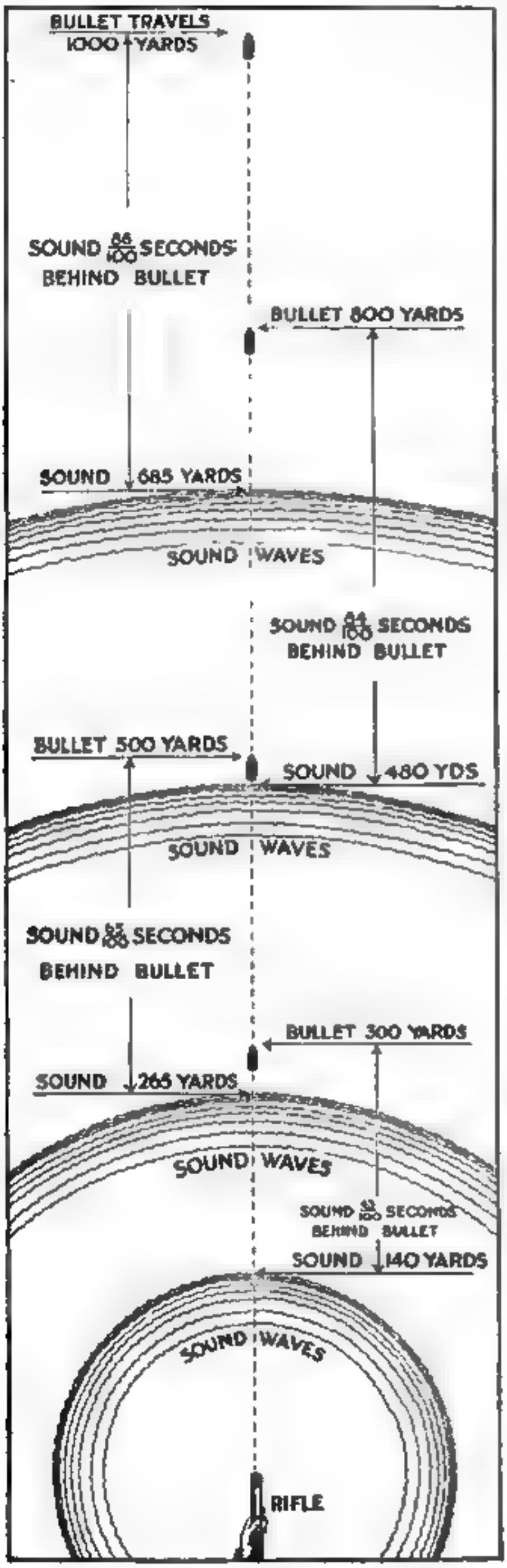
Photograph by Ordnance Department, U. S. N

The bullet was photographed when six inches from the muzzle, just escaping from the blast gases of the rifle. Note the outline of the sound wave diverging from the nose of the bullet. This is the first stage of the exit of a bullet from a rifle's muzzle. It is not unlike the bow wave of a boat

We were walking not more than one hundred or one hundred and fifty yards from the line of fire of a trained infantry company, delivering its fire at a group-target twelve hundred yards, roughly three-quarters of a mile, away.

The thin, high-pitched crackling, that seemed at one time like the leap of the high-tension spark of the static machine, at another like the cracking of whips, and again like the vicious crash of a stone through glass, came from the flying bullets of the United States service rifle, which starts with the speed of twenty-seven hundred feet per second. The thudding, that fell off to almost nothing at twelve hundred yards, came from the rifles themselves, the only sound one hears when close to them, but the least noticeable at a distance when one is close to the course of the bullet.

As we gained the target, a new sound



Sound is slower than a bullet. Bullet crash and rifle report are heard one after the other. The crash is due to air rushing in to fill the vacuum behind the bullet

mingled with the irregular crashing of the bullets—a high-pitched whine, with an occasional vicious yowl punctuating the noise. This came from the ricochetting bullets, striking the ground short of the target and then glancing off and pursuing their erratic course through the air, their velocity much diminished, their travel changed to an end-over-end whirl, and the bullets themselves defaced and battered by the impact with the ground.

Back of the target the bullets passing through it went into the waters of the lake several hundred yards out, with the noise of heavy blows, almost as hollow and heavy as the impact of a well-swung carpet beater on a huge, loose carpet. Almost the same sound comes when a bullet strikes flesh, human or otherwise.

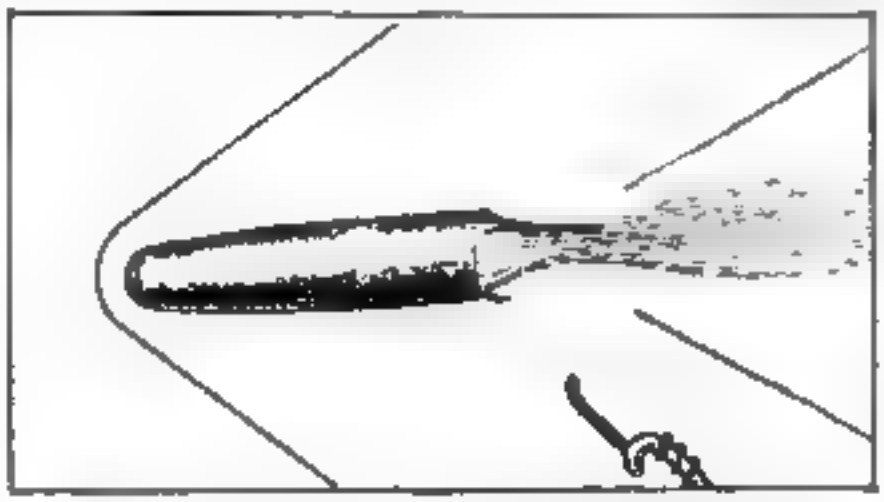
Normally the sound of the progress of the modern military bullet up to nearly a mile, is the high-pitched, ear-splitting vicious crash. At longer ranges it hums, probably from an increasingly unsteady flight. Or possibly it hums all the time, but the sound is killed by the vicious crash that accompanies the bullet while it is traveling fast.

Under some conditions of air and background, not yet clear to me, bullets hiss. The sound is noticeable at the skirmish, on the six hundred yard range at Camp Perry, and at the great matches. It is never heard at the range of the writer's club, situated in the hills with every chance for sound to be echoed back and reproduced, nor has the writer heard it on any other range. However, this hissing noise is audible only at the firing point. Trial out along the flight of the bullets developed that either they did not hiss to the person so located or else the hiss was covered up by the usual crash, which amounts to the same thing in the end.

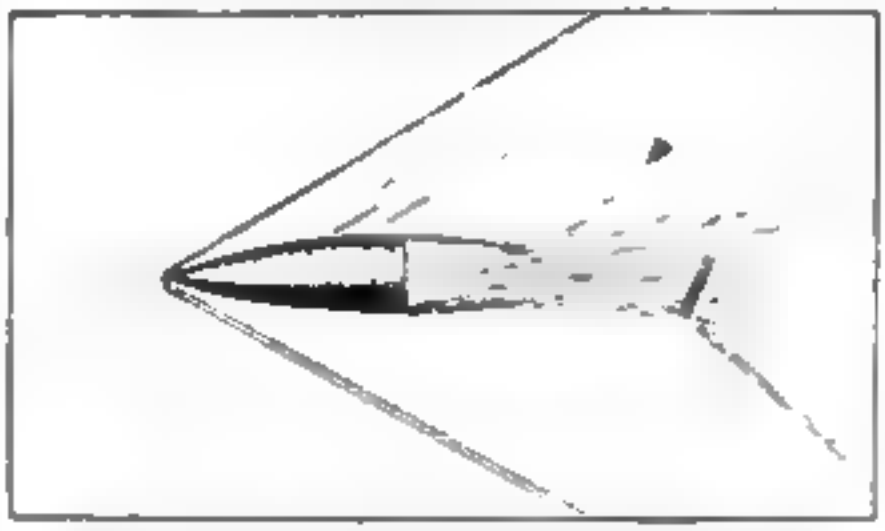
Never do bullets howl unless they have been tipped out of normal flight by striking some obstacle. The howl is merely the noise of a more or less jagged missile whirling end-over-end, while the normal bullet, traveling nor-

mally, slips through the air like a trout through water.

The soldier, fired on and missed by a single sniper without other sound to confuse or cover up that pertaining to him, hears two distinct sounds, if the firing takes place within four hundred yards or so. Phonetically they are "Pack-punk." The first is a vicious and menacing crash. It is the bullet arriving with its regards to him; the second is the report of the rifle which follows along some distance behind the bullet. The modern bullet travels faster than does sound, which has but the speed of eleven hundred feet per second. The person watching the jet of steam from the whistle of the far-off locomotive and noting the interval of time which elapses before the whoop of the whistle arrives, will appreciate that sound is a leisurely traveler.



Drawings from photographs of bullets in flight. Showing older type, metal jacketed, small bore military bullet in flight. Note bow wave of air driven ahead of the bullet, and the eddies of air in the wake like water in the wake of a ship. Directly in rear of the base of the bullet is the vacuum that causes the sharp crash as the air closes suddenly in upon it



The flight of the modern spitzer bullet, which is used by Germany, England, France, the United States and some other nations. Note the sharper angle of the bow wave, and the greater vacuum in the rear of the bullet. This is caused by the fact that these lighter sharp-point bullets are driven at far higher velocity than the older type, and the vacuum is more pronounced. Also the noise is more marked. A bullet which tapered down to the stern as sharply as the point of the bow would have little vacuum and little noise. The photograph from which this sketch was prepared was made by Professor Boys by means of an electric spark produced as the bullet cut the wire

The crash comes from a vacuum formed in the rear of the flying bullet by its enormously quick displacement of air. The bad shape of the missile allows the air to flow back again around the stern, like water around the stern of the fast moving boat. Finally, the air rushes in behind the bullet and makes the crash just as the air rushes in behind the electric spark.

Only at speeds higher than twelve hundred or fourteen hundred feet per second is this sound heard. Strangely enough it is not heard if the bullet has started at very high speed and falls to this lower one. Possibly what is heard in such case is the crash of the bullet at some distance farther back where the velocity is still high enough to produce a crash.

Military rifles drive their bullets at speeds of from two thousand to three thousand feet per second. The same bullets, loaded to give velocities of less than fourteen hundred feet per second, do not make a sound. So, black-powder or low-power rifles like the familiar .22, do not produce this crash from their bullets. The difference in the arriving time of the two sounds, bullet crash and report of the rifle which fired it, is very noticeable at the long ranges. At one thousand yards, for instance, the bullet of the United States rifle arrives at the mark 1.86 seconds after it leaves the muzzle of the rifle. The bullet thus covers the distance at the average speed of about sixteen hundred feet per second. Sound, traveling at the uniform rate of eleven hundred feet per second, takes 2.7 seconds to make the trip, and the bullet and its accompanying crash, thus arrive nearly a second ahead of the report of the rifle. So comes about the phenomenon of the two distinct sounds; first the bullet crash, and then the report of the rifle.

A special pair of steel braces was used to straighten the crooked legs of this valuable baby llama

Straightening a Baby Llama's Knock-Knees

IF mechanics had not come to the rescue of a valuable baby llama at the Cincinnati Zoological Gardens, he would be a useless little llama now. Llamas with knock-knees are not wanted by any zoological garden.

He was made a perfectly good llama by the use of a special pair of steel braces so constructed that they would straighten out the crooked legs and in the meantime allow him to enjoy life by frisking around with his mother like an ordinary baby llama.

To accomplish this unusual task of straightening out the legs, a pair of steel braces were constructed, each having six straps so attached that they buckled around the legs. Thus the braces were held securely in place. The straps were tightened day by day and gradually drew the legs closer and closer to the steel braces so as to straighten out the curves.

At first the little llama refused to walk with the braces on his legs. Soon he got over this and frisked about with his mother as if the stays were not on his legs at all. Freedom of movement was accomplished by hinging the braces at the knees, so that they could bend naturally in walking.

It took two weeks to draw the legs into normal position. As a matter of safety, the braces were left in place until the legs became strong enough to bear the weight of the animal.

Vegetation that Thrives Where Water Is Scarce

THE weather in the deserts of our great Southwest is such that only three months in the spring are sufficiently moist to permit any considerable vegetable growth. The cactuses, which are practically the only form of vegetation courageous enough to live in such arid regions, protect themselves in an almost human way against destruction. The outer coat of the barrel cactus, shown in the illustration, is almost as strong as bark and is armed with long formidable spines, arranged in rows of clusters. These rows are an effective barrier to most animals seeking the inside of the cactus, which is composed of pith soaked full of water. The water is stored up during the short rainy season, as squirrels store nuts for winter.

A traveler quenching his thirst from a barrel cactus

A New Powerful Farm-Tractor

ONE of the most powerful of the many farm tractors now on the market has recently been offered to the public. This new machine is remarkable not only for its great pulling power, but for the ease with which it plows through almost impassable swamp, marshes and beds of streams.

The features of construction that permit of successful usage under such severe conditions are the double-worm drive and the swivel action of the axles. The four-cylinder develops sixty horsepower, but since this power is directed to both front and rear axles, great tractive ability results.

This four-cylinder tractor develops sixty horsepower, which is divided between front and rear axles, affording great tractive ability

Killing Insects with Poisonous Gas

FRUIT growers of California who have long contended with insect pests are now employing a new method of killing the pests, which is said to be exceedingly efficient. Under the old system of spraying the trees, the best result that could be obtained under the most favorable conditions was the removal of from eighty to eighty-five per cent of the insects. By fumigating the fruit trees with hydrocyanic gas, it is said that one hundred per cent results are usually obtained.

A gas-making machine has been recently placed at the disposal of the fruit growers, which mixes the component parts of the gas and liberates the fumigating gas in any desired quantities. In the employment of this machine, a tent is placed over the tree which is about to be treated. By means of markings on the canvas the number of cubic feet occupied by the tree is accurately measured, and the amount of gas to be employed is thus decided. It has been discovered that the strength of the gas mixture to be used depends upon the size and age of the tree. On the average tree, from ten to fifteen feet in height, a strength of about one ounce of cyanide to one hundred cubic feet of gas is the average dosage.

The proportion of cyanide, acid and water is adjusted in the machine. The usual proportion is that of equal parts of cyanide and acid, but the proportion of water varies from two to eight parts.

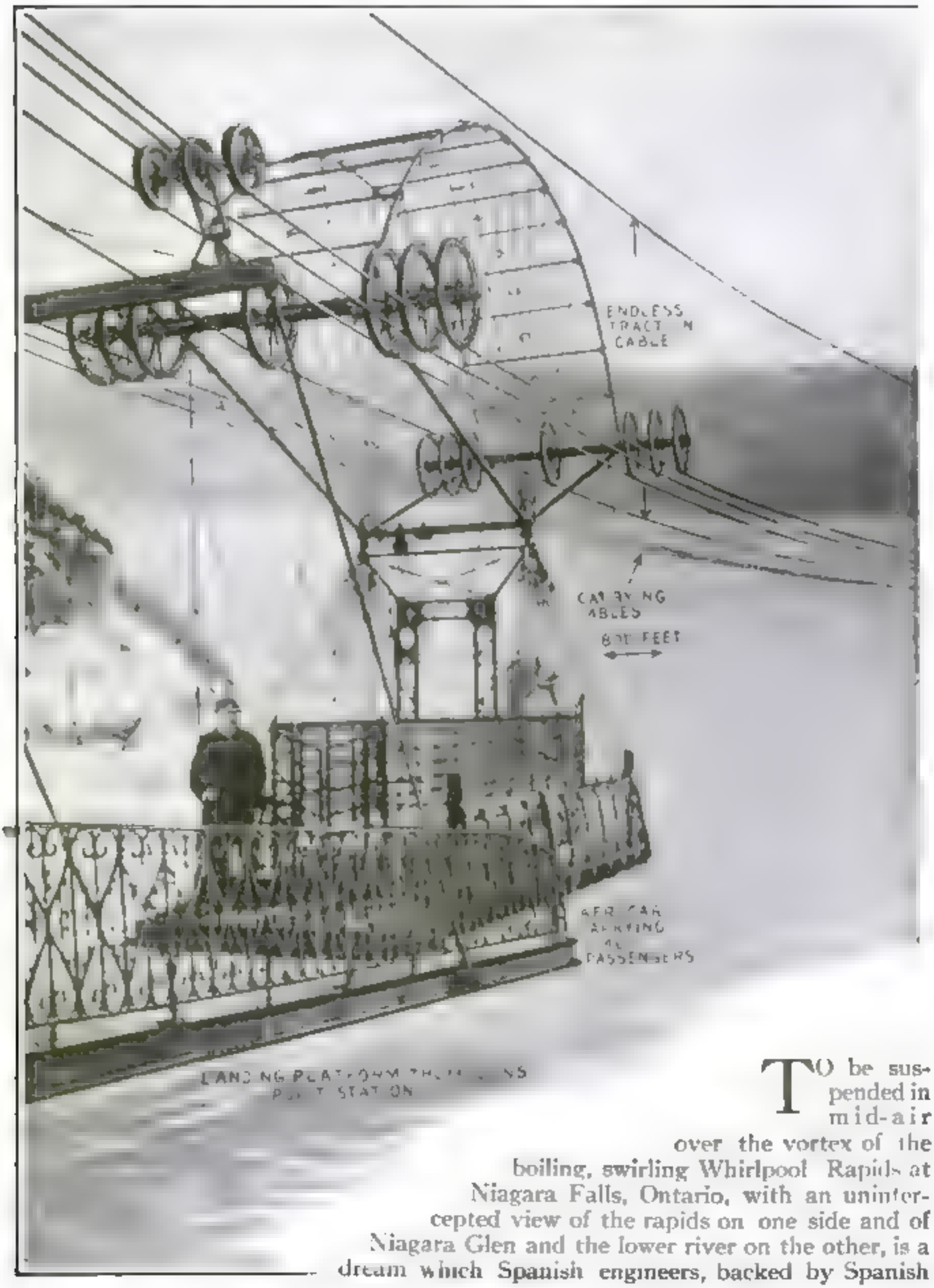
The gas is liberated under the tent, and permeates the enclosed space, thus fumigating every branch and leaf of the infected tree. The gas is held in the tent for about an hour, when all the insects are usually found to have perished.

The ordinary equipment employed by contractors to fumigate an orchard consists of one gas machine, of the type shown in the illustration, about thirty tents, and a staff of five or six men.

An equipment for fumigating an orchard consists of one gas-machine, about thirty tents and five or six men

Niagara's New Air Route

By Charles W. Person



TO be suspended in mid-air over the vortex of the boiling, swirling Whirlpool Rapids at Niagara Falls, Ontario, with an uninterrupted view of the rapids on one side and of Niagara Glen and the lower river on the other, is a dream which Spanish engineers, backed by Spanish

capital and patents, have realized. An aerial scenic cableway now spans the Rapids from cliff to cliff.

For sheer excitement and thrill the trip by air over the Whirlpool outdoes anything that tourists have ever experienced. True, there is the first stage of the cableway which climbs the Wetterhorn in Switzerland; but it can not compare in magnitude with the Niagara project. Then there is the tramway at San Sebastian, Spain, for the transportation of tourists from a trolley terminus to a casino overlooking the Bay of Biscay—the only previous installation of the system in use at Niagara Falls and owned by the same company. But, the span at San Sebastian is only nine hundred and nineteen feet, while at Niagara it is eighteen hundred feet. It may be safely said that Niagara now has the longest and probably the safest scenic cableway in the world.

It was the successful operation of the San Sebastian cableway, for the past six years, during which time it carried as many as twenty-six thousand passengers in a single season, which brought Torres y Quevedo, the inventor of the system, to Niagara Falls. No time was lost in starting operations. Work was begun July 12, 1915. The cables are now erected, and cars are now running upon them.

Diplomacy and Engineering

The Whirlpool is situated some three miles below the Falls and is almost entirely within Canadian territory. Hence, the two anchorages or terminals of the cableway, Colt's Point and Thompson's Point, are both in Ontario. Because the boundary line between New York State and Ontario forms an acute angle, which is intersected by the cableway about sixty feet within the apex, the promoters found themselves in a diplomatic tangle. After securing the sanction of the Province of Ontario

and of the Victoria Park Commission of Niagara Falls, they had to obtain permission from Albany, since the bed of the river is owned by New York State, and from Washington, since the water is owned by the Federal Government.

But the restrictions did not stop here. The engineers were cautioned against erecting a cableway which would cross the tracks of the Niagara Belt Line Railway, and they were further warned against damaging the cliffs on either side of the Whirlpool. To increase their difficulties they were forbidden to build any towers or structures which would rise above the level of the tracks of the railway running along the cliff.

Heavy rock excavation at Thompson's Point. The Whirlpool appears below

This first cableway of its kind in America was built at a total cost of sixty thousand dollars, exclusive of engineering expenses and exclusive also of the car and loading platforms, both of which were built in Spain. With past experience to guide them, the promoters have no doubt a duplicate installation could be built for forty-five thousand dollars.

The Torres system is simple in the extreme. It consits merely of six parallel carrying or track cables which hold the passenger car, each cable being securely attached to a fixed anchorage at one end of the line and to a counterweight system at the other. The cables are fastened at Colt's Point to a seven hundred and forty-one ton concrete block, and at Thompson's Point each is attached to a ten-ton counterweight or stretcher after passing over a grooved sheave. These counterweights move freely up and down in steel guides, as the load is diminished or increased. Thus, the tension upon the cables is not increased by the weight of the car, although the deflection of the cables is, of course.

In other words, a sudden load thrown upon the cables causes the counterweights to rise and the cables to sag. The greater the load on the cables the greater will be the sag. But the tension will not be increased; it always will be ten tons to the cable. Thus, the tension in the track cables depends solely upon the counterweights and not at all upon the weight of passengers borne by the car.

Suppose a Cable Should Snap?

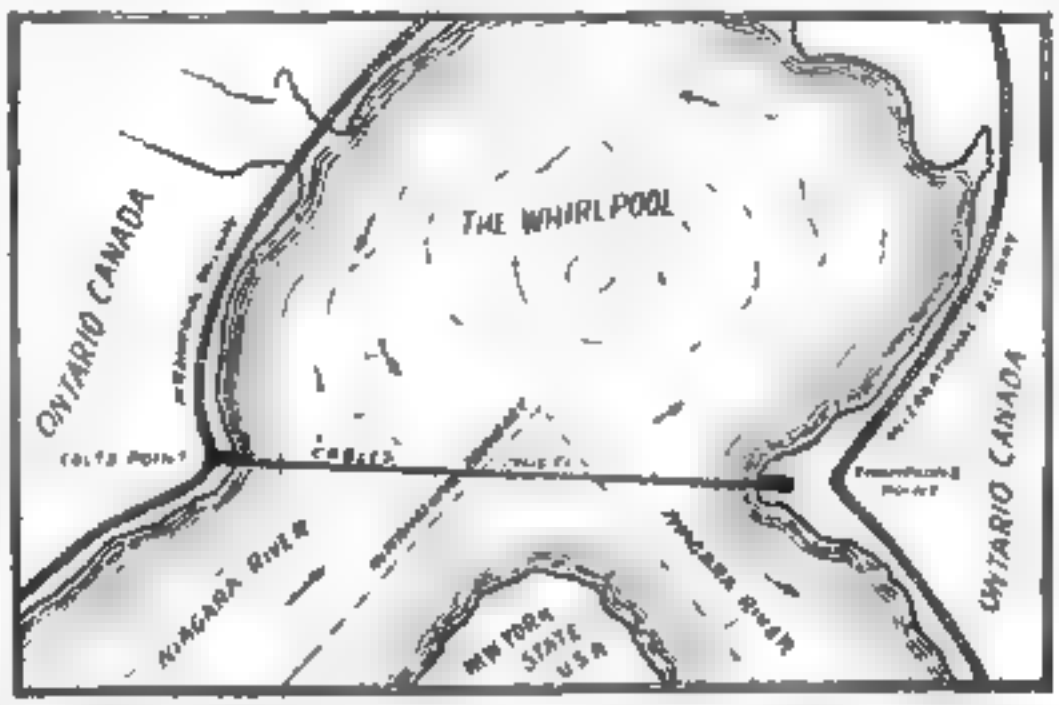
For this reason the sudden breaking of any one track cable would not be serious, as the other cables would support all the weight of the car without any increase in their tension. Should a cable break, the car filled with passengers would fall suddenly and then bob up and down until it assumed a new position of equilibrium. The breaking of two cables at the same time is considered impossible by the engineers.

The simplicity and safety of the Torres system lie in the fact that each cable is put into fixed tension from the start of operations, that this tension never varies, that the resistance of the cable can be verified at any time by increasing the load on the counterweights, that if any cable or fastening is faulty it will probably break when heavily weighted for trial or inspection trips, and that if a cable does break practically no extra strain is put upon the other cables.

The passenger car is propelled by a traction cable fastened to a ten-ton

counterweight box, arranged in steel guides similar to the track-cable counterweights. This creates a tension which adjusts any slack caused by the rising and falling of the car. At San Sebastian the car holds only fourteen passengers, but at Niagara seats are provided for twenty-four passengers and standing room in a raised aisle for twenty-one more besides the conductor.

The engineers have determined to a nicety what would happen to the car if the traction cable were to break. As the two terminals are nearly at the same height above the river level, one being 249.5 ft. and the other, 246.5 ft., they figure that the car would run backwards and forwards along the track cables until it came gently to rest at the lowest point of the sag of the cable, which would be about the center of the span or directly over New York State. A light basket which holds one man and which hangs from pulleys which can be readily thrown over two of the track cables, would be used in the rescue work. The emergency man would attach a relief cable to the marooned car, and an auxiliary engine installed for the purpose would pull the car back to Thompson's Point.



Map showing cableway. Note the small portion which extends over New York State

Some Interesting Safety Devices

There are several safety devices of ingenious construction, among the number being an automatic control stop which halts the car within three feet of the concrete station. A clamp on the car strikes the face of the control stop, prevents the car from traveling farther, and then engages with it in such a manner that the car cannot slip back from the landing platform. Furthermore, the car gates cannot be opened until the clamp has engaged with the control stop, and even then only the right gates can be opened. In addition to this, there are limit switches which prevent the power from being turned on again, and thus jam the car against the station once the power has been shut off.

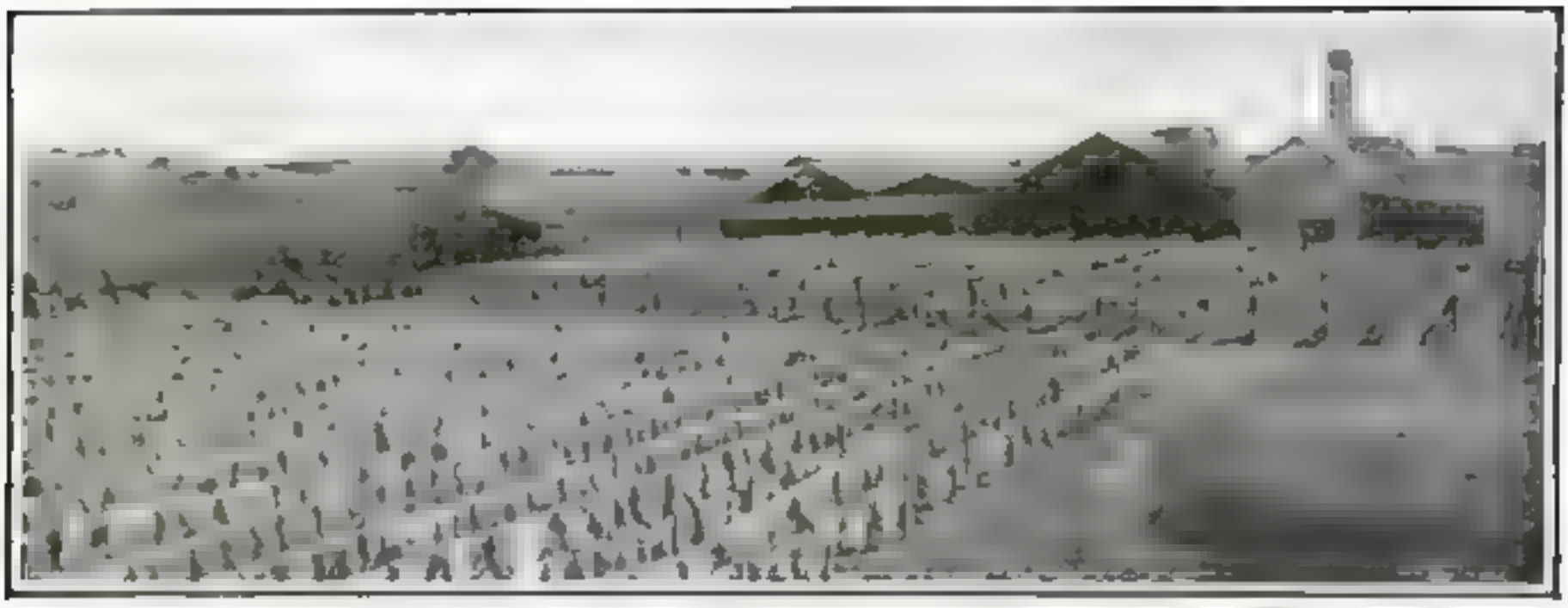
To string the cables across the Whirlpool the traction and track towers and sheaves were first erected. Then a long rope was carried around the face of the cliff from Colt's Point to Thompson's Point. When this was pulled taut a wire rope was hauled across with the aid of a hoisting engine, and then the traction cable was pulled into place. This cable was used to haul the track cables across.

The trip from from point to point can be made in about five minutes. To test the car cast-iron bars weighing thirty nine thousand and nineteen pounds, or three times the working load of the car with forty to forty-five passengers, were distributed on the floor. A trestle was built and the car was suspended by its wheels from it. The test was satisfactorily met.

Inventions for the Navy

LAST July, Secretary of the Navy Josephus Daniels announced the creation of a board, afterwards designated as the Naval Consulting Board, headed by Thomas A. Edison, for the purpose of aiding in the development of the Navy and the defense of the nation, by giving expert consideration to the many needs of the Navy and the many inventions that might be submitted to it. Public announcement of the creation of this board was accompanied by an invitation from the Navy Department to the inventors of the country to submit their ideas.

Seven months later, not less than five thousand inventions, ideas and suggestions had been received.



Advantage is taken in South America of the intense heat of the tropical sunlight in drying cattle hides. The odor is the most objectionable feature of this method

Drying Cattle Hides in a Broiling Tropical Sun

ONE of the strangest sights which will greet the traveler from the North in visiting the small tropical countries along the eastern coast of South America is an occasional large tract of land covered with long racks of wood upon which are strung cattle hides drying in the sun. Whenever one of these interesting tracts is approached the visitor after one or two experiences does not have to be forewarned; the odor which arises from them is almost unbearable. The intense heat of the tropical sun causes rapid decomposition of the fleshy parts, which cling to the hides, so that they dry quickly; but while they are drying the stench that emanates from them is sickeningly offensive.

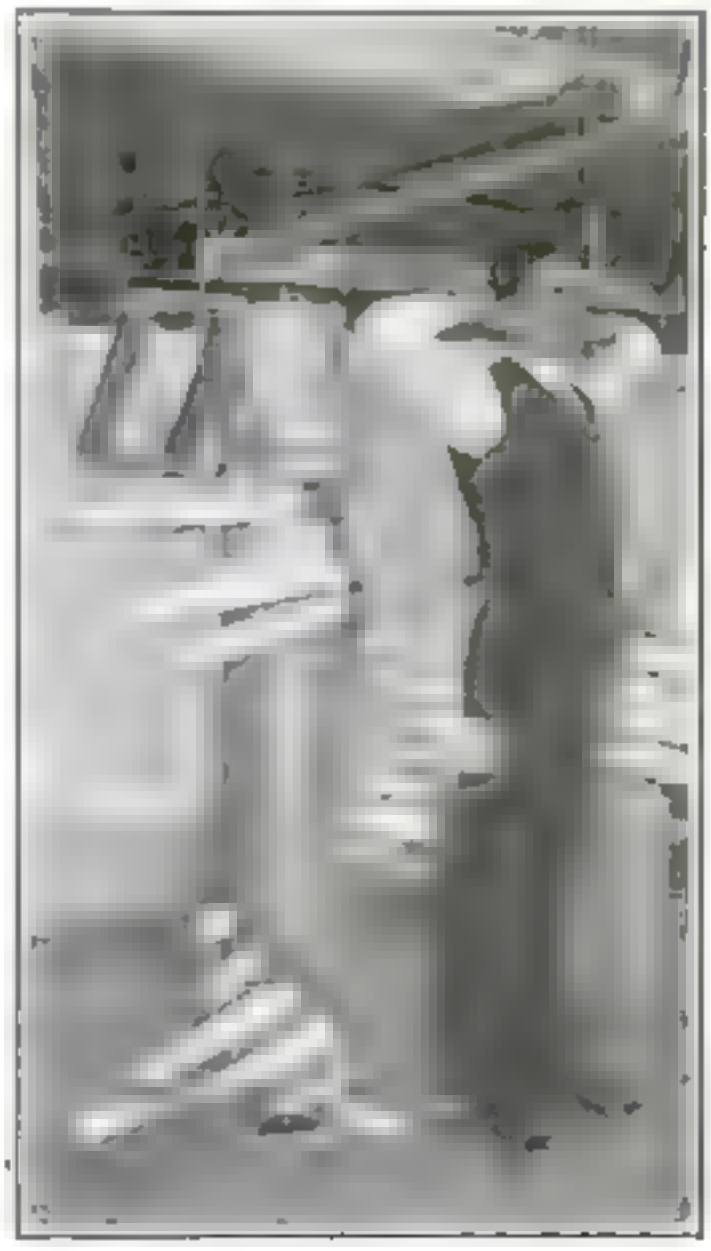
Dried hides comprise one of the chief means of revenue of Uruguay.

A Whipping Machine to Cure Nervousness

THERE must have been merit in the "birch tea" of childhood, for the same remedy is prescribed in sanitariums nowadays for invalids. In other words, it is considered that a healthy reaction may be gained from a "spanking."

In the mechano-therapy departments of up-to-date institutions, the "whipping post," a mechanical device for therapeutic paddling is an accredited healing-machine.

You are whipped by straps of heavy cloth or leather attached to two rapidly revolving posts. When you take the treatment you step backward into the flying whips and receive their blows upon your legs, back, abdomen or chest, depending upon the malady from which you are suffering. The impact of the straps is just sufficient to set the blood in free circulation. There is no smarting, stinging sensation because the straps are broad enough to eliminate any possibility of a cutting blow. You are paddled rather than lashed.



His nervous, tired body is receiving a soothing series of slaps

The "whipping post" is valuable in many types of nervousness. It is also valuable in increasing blood circulation and relieving numbness. Certain forms of paralysis though not responsive to other treatment, are benefited.

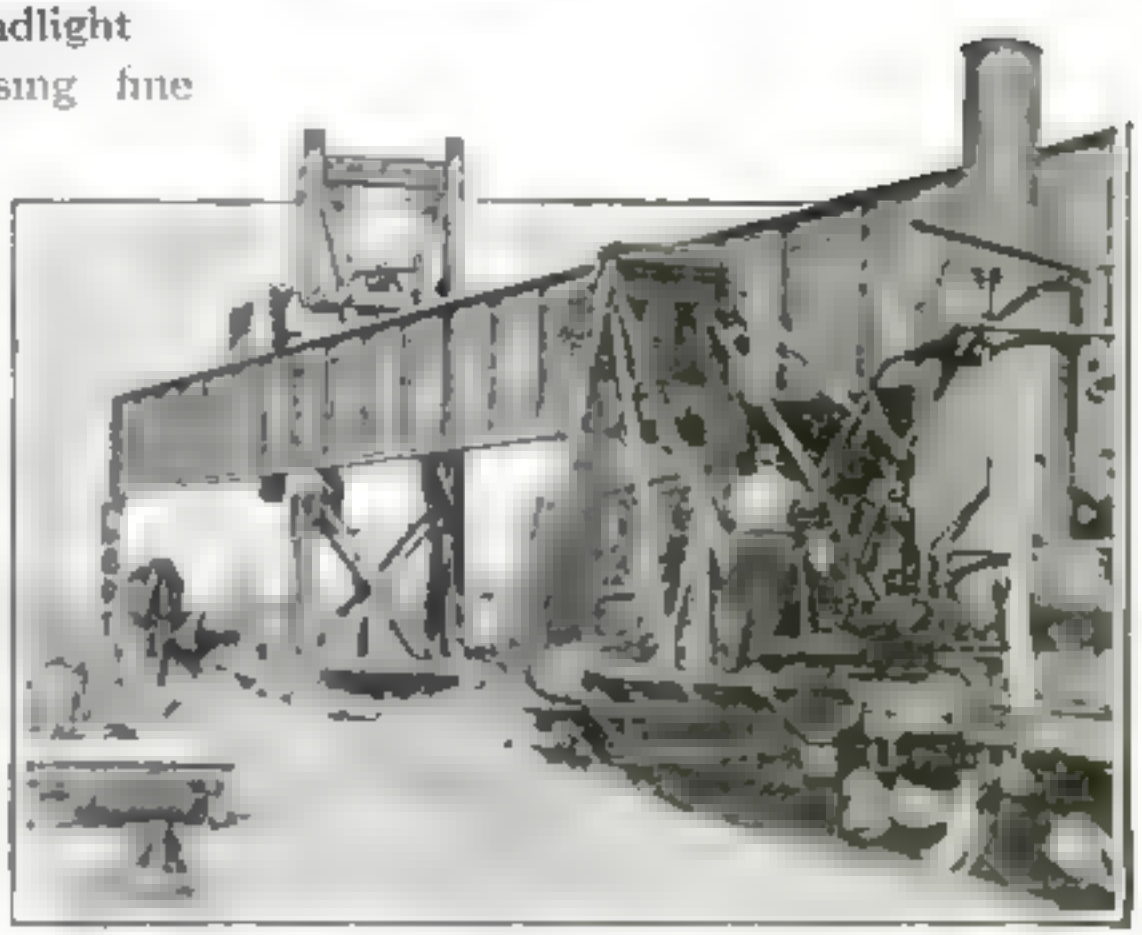
An Electric Iron With a Headlight

AN electric iron for pressing fine linen, elaborate centerpieces and similar articles, where extreme care is highly important, has a small electric lamp in the same position that a head lamp occupies on a locomotove. The lamp is shielded from accidental blows by a metal cap attached to the end of the handle, the shield also serving as a reflector, concentrating the light upon the work in hand, and preventing the rays from shining in the eyes of the operator. The lamp is connected across the heating coils, taking its current from the cord which runs to the socket.

This electric iron with a headlight is just the thing for ironing when it is necessary to use special care

How Record-Breaking Girders Were Handled

TO erect record-breaking girders weighing up to one hundred and thirteen tons and up to one hundred and thirty-two feet long, in connection with grade-crossing elimination work in Chicago, required a plant unusually sturdy and capable of quick work. Every operation had to be known beforehand; for two of the five spans were over high-speed tracks where a maximum of only two hours' interruption to tracks could be allowed. That the calculations of the bridge engineers was correct is evidenced by the fact that the fifteen girders were all placed without exceeding the allotted time.



By planning each move beforehand, these huge girders, weighing over a hundred tons each, were handled easily

A tower was designed which would straddle the track below, its columns or legs resting on wheels which rolled along the rails, so as to enable the workmen to place it at the exact spot desired. The tower was then securely blocked up on sills and the lower cross-bracing removed to allow the heavy girders carried on four steel flat cars to run beneath. A huge pair of hooks then took hold of the girder by its upper flange and lifted it to the proper elevation, so that it could be swung around until its end bearings would come over the steel columns, whereupon it was lowered into place. Power to raise the girders was supplied by giant derrick-cars through steel cables, one of which may be seen near the top of the rail in the accompanying illustration.

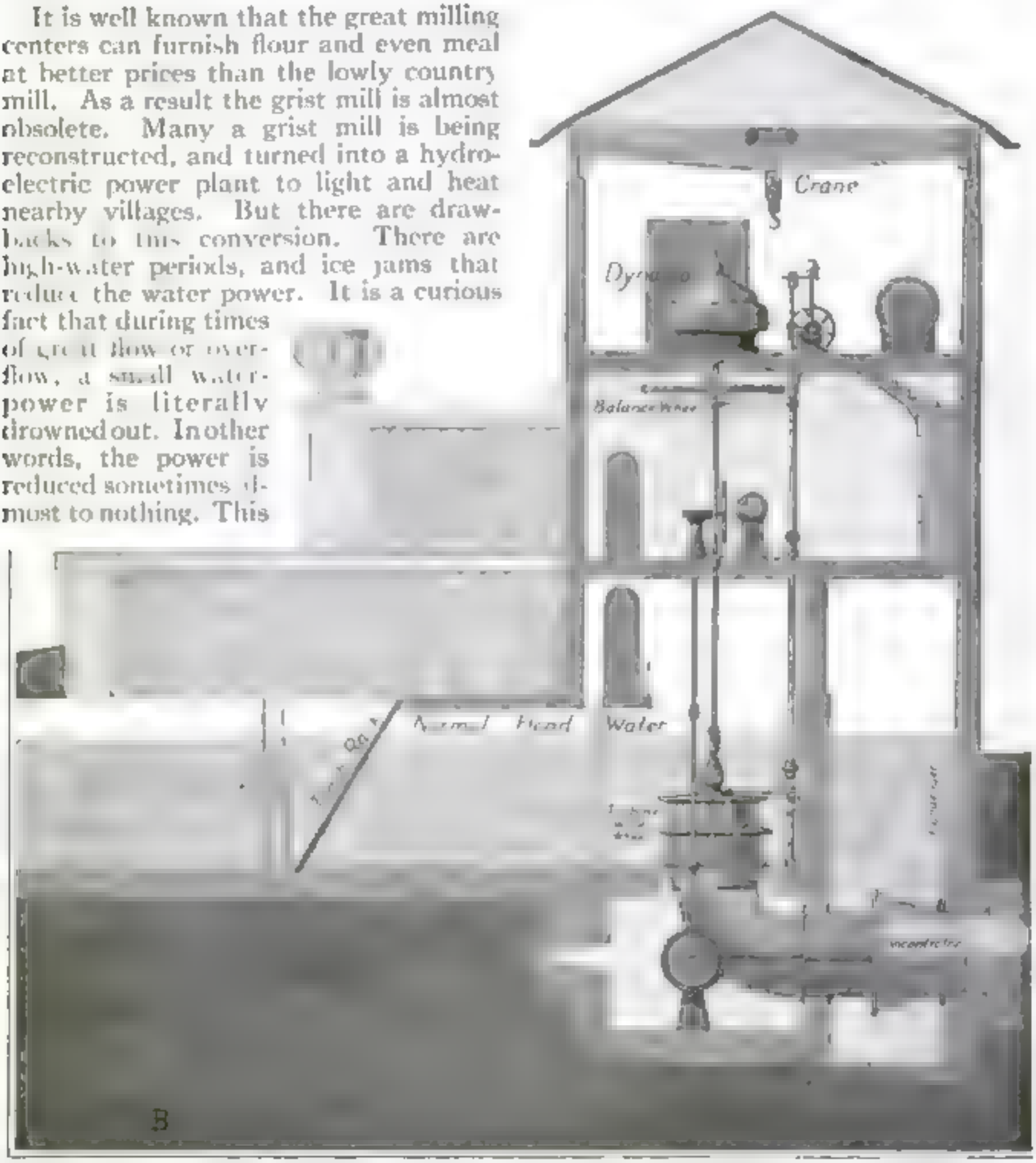
Removable leg sections or "gates" in the rear of the tower provided for disengaging it from the girder just erected and moving it to the next. After the three girders in one span were in place, the tower was jacked up on a bed of greased rails along which it was slid across the tracks to the next span.

The girder, when hoisted in the air, could be moved only a trifle endwise because of its weight, and hardly at all laterally.

A New Era in Water Power Begun at the Henry Ford Farms

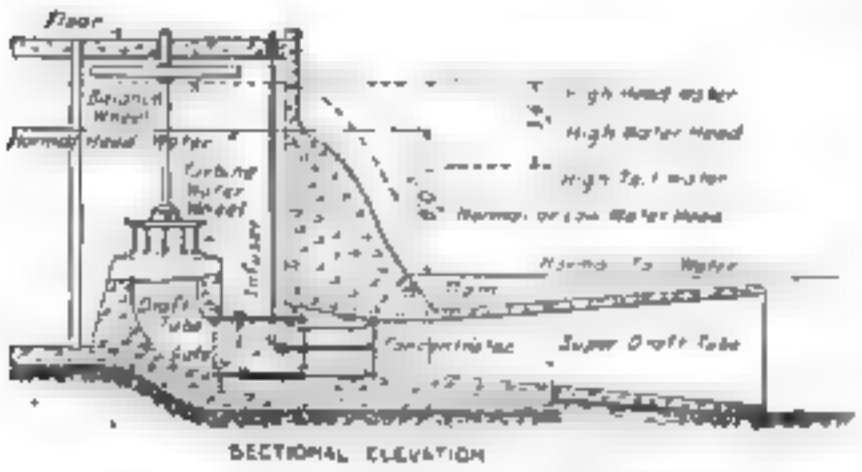
HENRY FORD'S Farms serve as an experimental field for the various appliances being developed by Mr. Ford. His new home is located on the farms. This is near Dearborn, Michigan, on the north bank of the river Rouge, on the site of a pioneer mill.

It is well known that the great milling centers can furnish flour and even meal at better prices than the lowly country mill. As a result the grist mill is almost obsolete. Many a grist mill is being reconstructed, and turned into a hydro-electric power plant to light and heat nearby villages. But there are drawbacks to this conversion. There are high-water periods, and ice jams that reduce the water power. It is a curious fact that during times of great flow or overflow, a small water-power is literally drowned out. In other words, the power is reduced sometimes almost to nothing. This is due to the fact that water rises faster below than it does above a dam during a freshet. The tendency is to conceal even the location of a dam in very high water. Hence, the head pressure on the turbine water wheel is reduced, so that little or no water will pass through it, with the



The water power plant here shown is located at the Henry Ford Farms, near Dearborn, Michigan. The low head of water is increased by use of an "accelerator" which relieves the

result that it cannot drive its generator during high water periods.



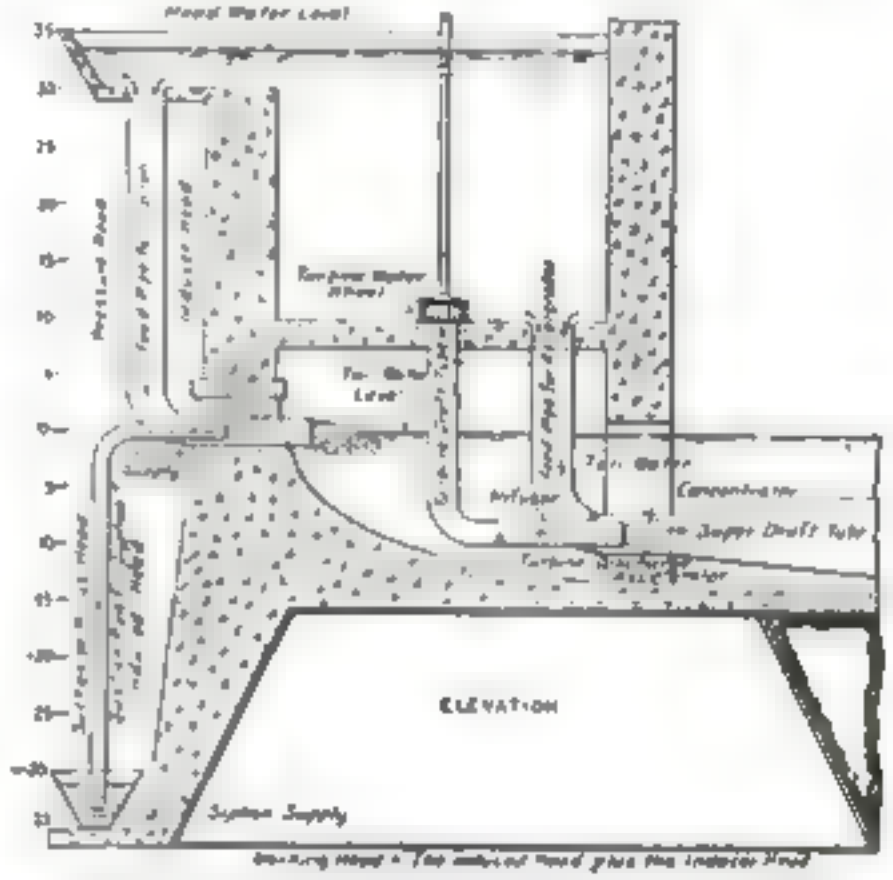
Vertical section through the turbine and concentrator, showing different water levels and other details

The current consumer needs his light and power during rainy seasons and thaw periods. Therefore, the small water power has been considered a hazardous investment without a steam engine or gas engine in reserve.

The river Rouge is a sluggish stream draining a wide flat valley. It flows into the Detroit river, which is often affected by winds on the Great Lakes. This causes the Rouge to back up and lower the head at the Ford dam at times when other conditions are favorable to good power.

The farms' water power has been modernized. It is now an electric station which provides current for the village pumping station, for Mr. Ford's home, and the various requirements of the farms. The problem of variable heads, and variable flow, in connection with constant requirements, was of special importance. Therefore, some new ideas and new apparatus were developed in the solution.

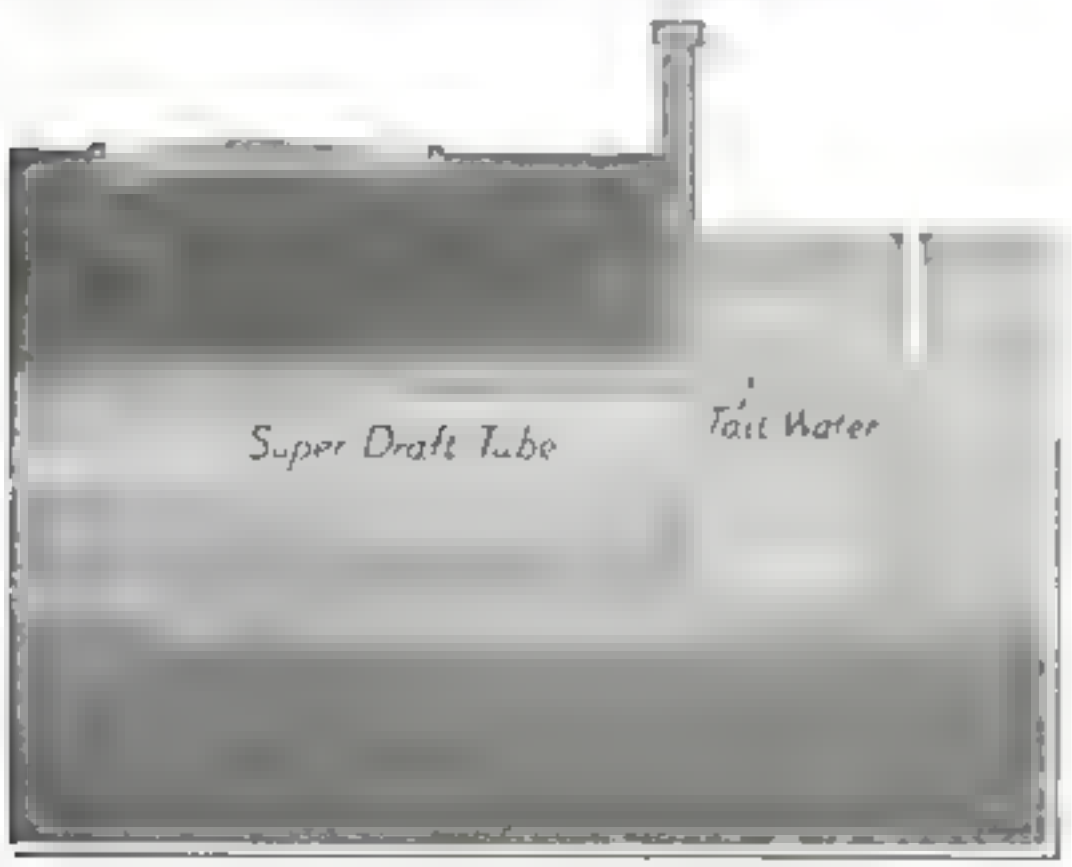
As has been already stated there are times of excess flow, in which the actual head pressure on the turbines is lowered. If a greater number of turbines were installed to use this surplus water the cost, together with the expense of larger foundations and buildings required, would be prohibitive from an investment point of view. This made it necessary to try to increase the head by the use of the surplus water itself, in other



The concentrator is in reality a tube within a tube, acting somewhat like a siphon

words, to set the mischievous water to work. This was done to the extent that the turbines can develop more than their normal power at times when they otherwise would be rendered powerless.

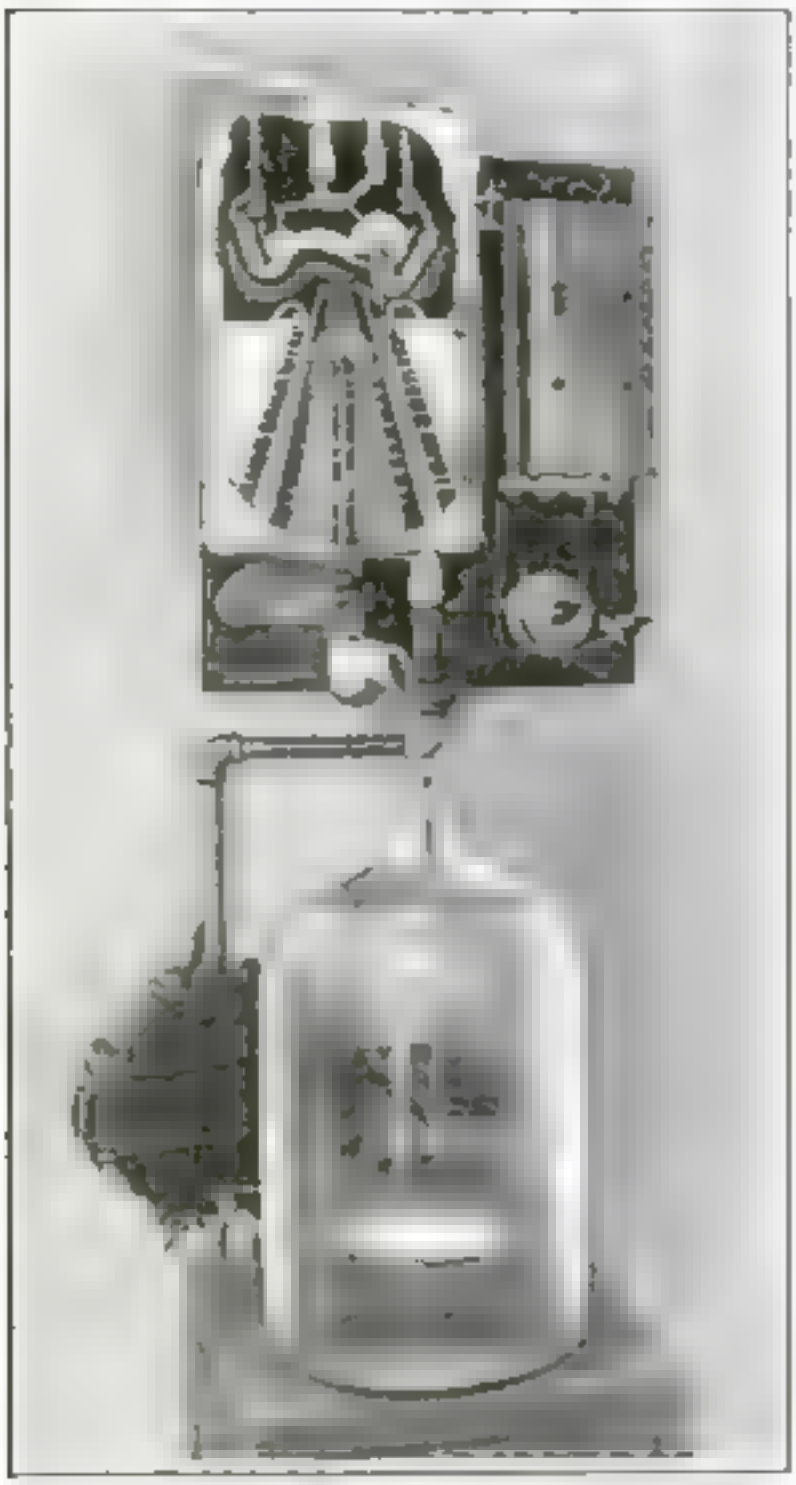
This was brought about by an apparatus which leads a portion of the surplus flow to the turbine discharge pipe in such manner that a vacuum is formed for the turbine to discharge into, thereby adding atmospheric pressure, or head, to the water head already acting on the turbine. This produces the full head conditions for the turbine. In turn, full power is furnished. This apparatus is called a



pressure at the lower end of the turbine, and augments the pressure at the intake end

"turbine discharge accelerator," because it can accelerate the flow of water through a turbine water-wheel. It is adjustable, and it can readily be regulated to the river conditions.

The illustrations will give a general



This household size apparatus will sterilize one thousand gallons of water for five cents

idea of the new device. The results were so marked as to appear incredible. Some of them are as follows:

1. The turbine wheel can be made to develop its normal rated power at half head.

2. The turbine wheel can be caused to develop nearly double its rated power at its normal head. (It will, of course, use more water in both cases).

3. The turbine can be made to develop a fair amount of power at proper speeds, when the head seems to be almost totally destroyed by high water. The latter conditions are extreme and are not often met in practice.

Sterilizing Water by Ultra Violet Light

ULTRA violet light is not visible to the eye, yet it affects a photographic plate, decomposes many chemicals, causes sunburn and sunstroke, and kills bacteria. Nature's purification of rivers owes something to the ultra violet portion of the sun's rays. Why not use it to purify drinking water? That idea has actually been carried out at Saint Malo, at Rouen and at Luneville, all in France.

The best commercial source is the mercury arc in which mercury vapor in a high vacuum becomes luminous as it conducts the electric current. The ultra violet cannot pass through the glass. Hence, the lamp tube must be made of clear quartz, one of the few solids transparent to these rays.

The light tube is a "pistol lamp," as it is called, because it is bent into a U-shape and enclosed in a quartz jacket as a protection against the cooling effect of the water. The pistol tube is immersed in the flowing water while the connections are outside the tank.

The capacity of apparatus now in the market varies from twenty gallons an hour to ten thousand gallons an hour or, by increasing the number of units, to any figure for large city water plants. An experimental plant in one American city forces the water through concrete channels two feet wide, three feet deep and twenty-six feet long, affording a contact period of thirty seconds with the ultra violet rays. The pistol lamps are spaced thirty inches apart, and in front of each is a baffle of wired glass in which a rectangular opening is cut to divert the water against the quartz tube.

The smaller types are used in sterilization of drinking water for homes, clubs, hospitals, factories, etc., purifying swimming pools, sterilizing water for ice plants and can even be found with armies in the field. The Austrian army carries a portable type on a motor car. In five minutes after starting the generator the soldiers fill their canteen with sterile and palatable drinking water. The household size is efficient and economical.

What Blood Pressure Means and How It Is Measured

IF for any reason the blood pressure is raised, the blood circulates more freely through the brain as well as through the other parts of the body, giving a feeling of buoyancy and confidence. The man who is working at a terrific rate, however, must have a high blood pressure, but if continued above a safe normal point, it will result in the "burning up" of his vital forces, resulting in many organic as well as nervous disorders.

High blood pressure does not always mean one and the same unalterable thing. It may be a sign that the arteries have stiffened to such an extent that the heart is taxed to pump the necessary volume of blood through the arteries and with sufficient speed. It may mean an improper condition of the blood itself—viscosity—the old-fashioned "thick blood" come to life again as a reputable scientific fact. It may mean that the heart has become too big for its job, as when an "athlete's heart," trained to push a big stream of blood, keeps on trying to do so when the demands of office work do not require it. It may also result from excessive pumping of the heart due to abnormal mental stimulation in the form of worry, or continuous mental or nervous strain

A device for measuring blood pressure, an ingenious instrument called a "manometer," has recently been perfected. The instrument records the pressure of the blood on a diaphragm dial very similar to a steam-gage dial. The scale is divided into millimeters.

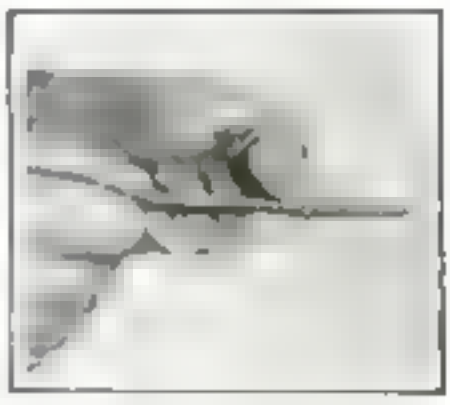
The apparatus, which is the invention of Dr. Thomas Rogers of Rochester, New York, is one of the most important surgical instruments devised in years, ranking with the pulmotor, stethoscope, and clinical thermometer. Its operation is comparatively simple, but its reading requires an expert. The best results are obtained when a stethoscope is used in connection with it.

The air-bag is first strapped on the subject's arm over the main artery, and is inflated with a bulb attached to it. The operator then adjusts a stethoscope to his ears and finds the pulse. The throbbing of the pulse against the air-bag is communicated through a rubber tube to the case containing the diaphragms upon which a vibration is set up. These vibrations, which are synchronous with those of the pulse, are translated into millimeters by the delicate needle of the dial

Manometer being used in measuring a man's blood pressure

A Clean Way of Removing Pens from Their Holders

A DEVICE for readily ejecting a pen from its holder without soiling the fingers has been invented by Joseph H. Bremer of Tampa, Florida. His penholder terminates in inner and outer sleeves, which are slotted longitudinally from their outer ends. In this slot a pen-ejecting bent steel wire slides to push the pen along. The shank of the wire is formed into a ring, which encircles the penholder. To remove the pen the ring is grasped and forced toward the end of the holder, and the bent steel wire pushes off the pen-point and thus spares the fingers.



A bent steel wire ejects the pen

Straw bottle-casings and a tack-hammer made this pleasant thatched garden-house

A Summer-House from Straw Bottle-Casings

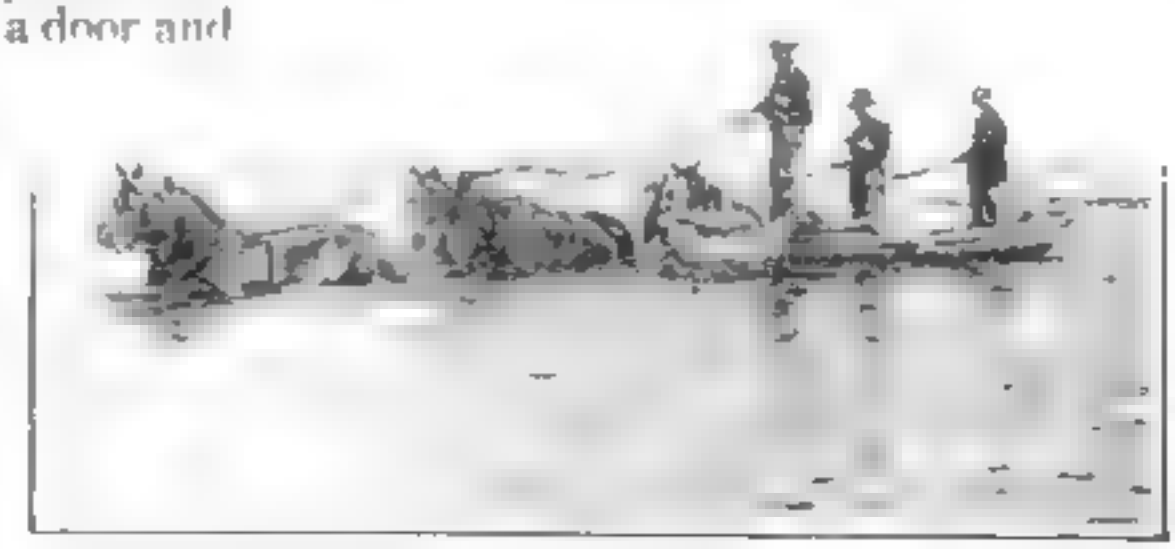
SHE was the thrifty wife of a restaurateur in a California suburb and the gardens about the establishment made it a point of interest for motorists from the city. The ambitious little lady thought that a summer-house among the palms and acacias would improve the grounds, but building material was expensive and so was expert carpenter hire. She was determined and practical "If I will furnish half the building material, and half the labor, will you furnish the other half?" she asked her husband, and he agreed willingly to the plan and thought nothing more of it until he saw carpenters at work erecting a very light skeleton of a summer-house. It was a frame of the lightest and cheapest wood—a few slender uprights on a circular ground plan and flexible half-inch boards which could be bent about them in a circle, the posts spaced four inches with an allowance for a door and a small window. It was a half-day's work for two men. "But that is no summer house!" the husband exclaimed. "There is no shelter there from wind or sun. It's no better than an onion crate!"

"Wait and see," rejoined his good wife. "My share of the summer house has not been contributed." She went down into the cellar. Presently she emerged, bearing an armload of what every one would call rubbish. The straw casings of wine bottles had been accumulating below for years, and her husband had planned to burn them some day. The straw was a nuisance, a fire menace, and a possible hiding place for rats. It proved to be anything but rubbish.

It was not damp or dirty, except for a bit of dust that could be shaken off That clever wife immediately set about tacking the straw casings upon the frame of the summer-house. It was the lightest sort of work, just a tap with a tack hammer and the wisp of straw, bound by its strands of twine, was in place. The casings were overlapped like shingles, so as to shed a light rainfall, and the roof was treated in the same way, the peak being topped with half a dozen casings bound into a conelike ornament. When a round table and a few chairs were set inside the summer house, it turned out to be one of the most popular corners of the place.

A Water-Wagon in Actual Use

A REAL water wagon, with passengers, may be seen in the accompanying illustration. These men are not on the water wagon for moral purposes, but are engaged in towing huge rafts of lumber through the shallow water at Carleton Point, Prince Edward Island. One raft is visible at the extreme right of the picture. The great weight of lumber necessitates the employment of six horses, which have become accustomed to wading and seem to like it, especially in hot weather.



By means of this horse-operated water wagon, huge lumber rafts are towed through the waters of Prince Edward Island

The checkered chart is a new and painless device, which quickly teaches the mysteries of multiplication, division and subtraction to the most reluctant pupil

Learning Arithmetic With a Woman's Invention

THE reason we honor Miss Albertina Bechmann this month is because she has invented a painless way of learning the multiplication, division and subtraction tables.

Her invention consists of a board on which are printed rows of figures from 0 to 144. The rows are separated by grooves. If you want to find out what 6 times 4 is, all you have to do is to find the figure 6, at the top of the board, and the figure 4 at the side, and to place a ruler in the groove nearest 6, as shown in the photograph, and another ruler in the groove nearest 4. In the corner made by the two rulers you will find your answer, 24.

If you would divide 24 by 6, you place one ruler between 6 and 24 and the other ruler in the groove running at right angles to 24, and, presto! you have your answer, 4, at the outside end of the second ruler. Also, by Miss Bechmann's painless system, 8 times 0 is never 8, as many children think. It invariably shows that 8 times 0 is 0.

If you would know what 6 plus 18 is, you hunt up the 6 column, and underneath the 18 you will find your answer, 24. If you would subtract 6 from 24 you would find your answer, 18, right above 24.

Austria Exhibits Paper Substitutes for Cloth

IT was announced last November by the Austrian Ministry of War that paper vests and foot coverings had been received for the forces in the field, and that the officials should instruct the men that paper, as a poor conductor of heat, was an excellent protection against cold. Attention was also called to the hospitals that paper was a good substitute for fabric, and that cellulose wadding afforded a sanitary dressing for wounds.

Later, at the suggestion of Max Schuschny, an exposition of paper products designed as protection against cold and a substitute for cloth, was held. The invitation to exhibitors brought fifty, and within five days twenty thousand persons had visited the exposition. Of all the useful articles exhibited, perhaps the most important was the "Danish quilt," consisting of crumpled newspapers. These coverlets have been used extensively for hospital purposes in the royal palace of Austria.

Some Ingenious For the

The bed can be set up in a few minutes and shelters the tourist from wind and rain

An Automobile-Bed for the Tourist

THE delightful independence of touring in an automobile can be improved upon by means of an automobile-bed. Wherever nightfall overtakes the traveler, he can make up his own cot and sleep in his own tent, completely sheltered from wind and rain and with no expense for a hotel room.

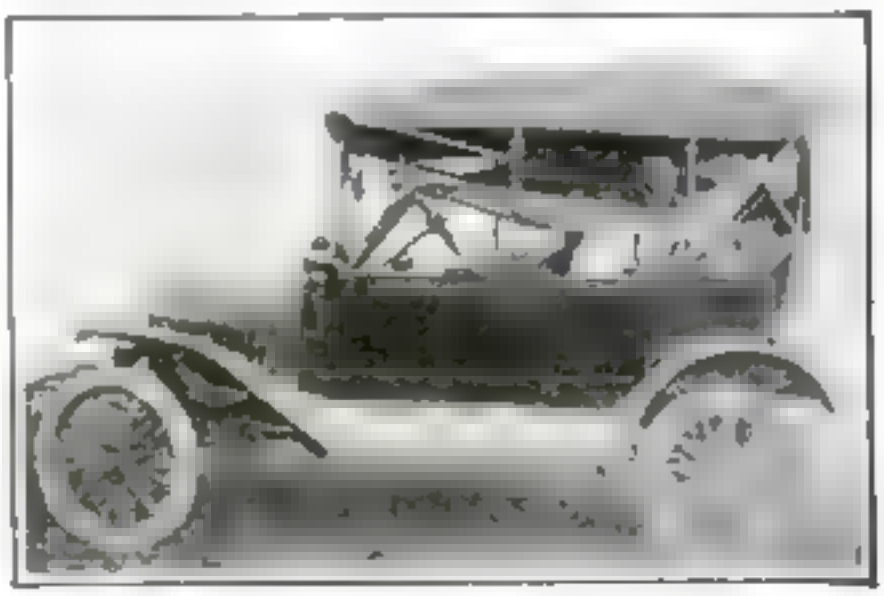
The metal frame of the bed is jointed in the middle; and a leg is attached at this point on either side. A cross-bar connects the legs, so that they will swing together when the bed is being folded up. One end of the frame pivots on a shaft secured to the side bars of the automobile, as shown in the illustrations. The two outer legs are pivoted to the frame

When not in use, the legs are swung up against the frame; the outer half of the frame is folded over the inner half, or foot of the bed; and the whole lifted to an upright position against the back of the tonneau. Small ratchet wheels at each of the joints are provided for holding the legs in position and also for locking the entire frame when folded up. A light metal framework is provided to be set up over the bed. Curtains are stretched over the frame to form a sort of box-tent, as shown in the illustration.

A New Ford Folding Bed

AN entire bed equipment which weighs but fourteen pounds, and which may be folded and packed away, with the exception of blankets and comforters, in a tool box, is the latest thing devised for Ford owners who wish to avoid hotel bills. The equipment includes a piece of strong canvas, two poles or iron bars for spreaders, one for the foot and the other for the head; four half-inch iron rods for supports leading from the car-top supports to the four corners of the canvas mattress, and four ordinary straps with buckles.

No changes need be made in the car other than to put two brass or iron rings in the dash to which the front straps are fastened. The half-inch rods resting at opposite angles on the car-top supports hold the canvas mattress above the seat tops, thus giving ample room beneath for "lower berths" for the children, while the straps running from the four corners of the mattress to rings in the dash and rings in the rear are buckled taut to keep the mattress from sagging. The bed is more rigid, due to this method of securing it, and it will



This car may be truly nicknamed "The Flying Bedstead"

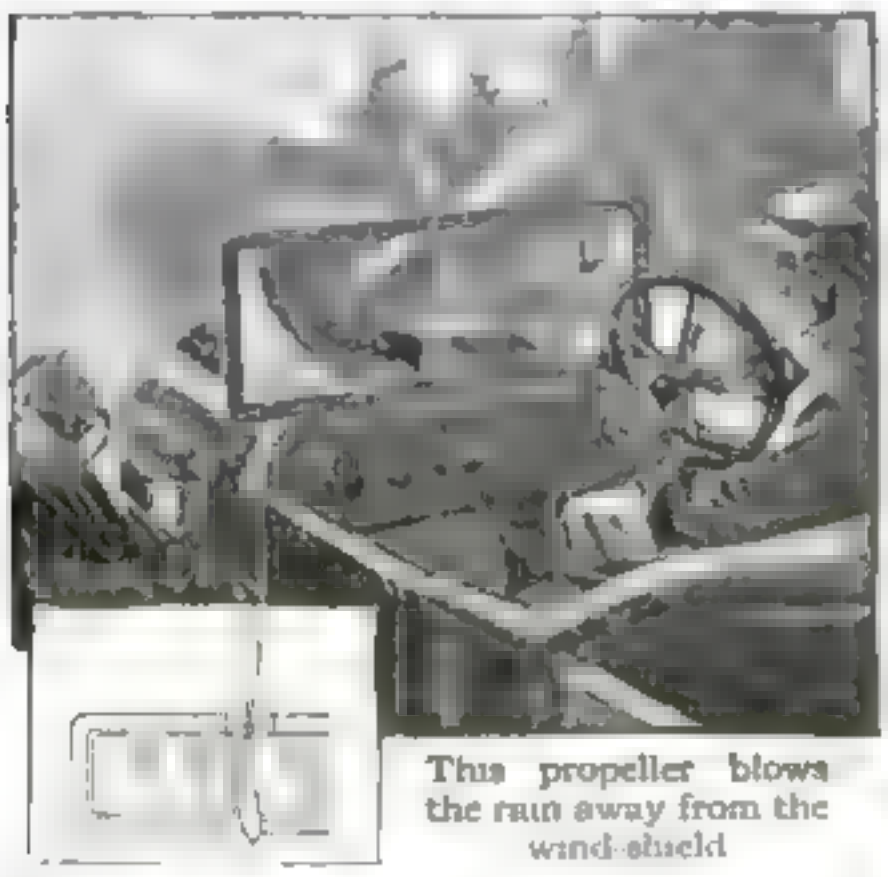
easily support two grown persons.

With or without a tent the bed equipment comes in handy on touring trips. For instance, it may be used as a lounging hammock by attaching short ends of rope at either end of the canvas bottom, or it may be used as a table-cloth.

New Accessories Touring Car

Rain Protector for Automobile Wind-Shield

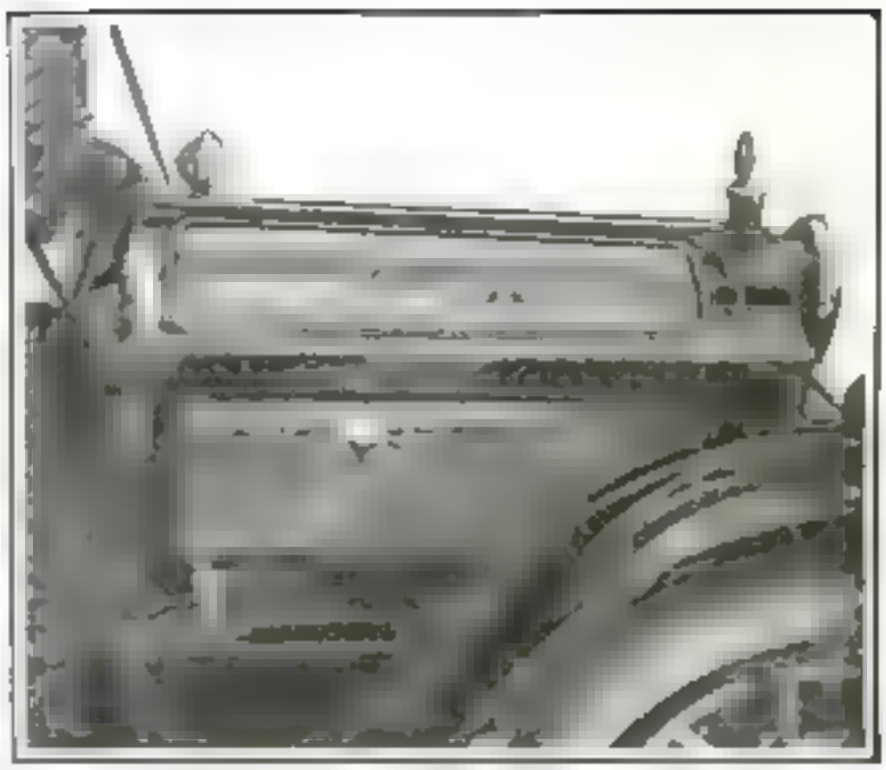
WHERE a wind-shield is used for the front of an automobile, the driver's view is dimmed by rain falling upon the glass. This is often a great drawback in running the car. Various means have been suggested for keeping wind-shields clean. The accompanying illustration shows one which has at least the merit of originality. A rotating propeller is used to drive off the rain drops. It is claimed that this is accomplished effectually, at the same time not obstructing the view, for it is a well-known fact that one can look through a rapidly rotating propeller.



This propeller blows the rain away from the wind-shield

A Handy Automobile Grease-Gun

A NEW grease-gun which saves the automobile man trouble when his machine needs lubricating, has been placed on the market. It consists of a can of grease. Attached to its side is a pump gun which pushes a quarter pound of grease into the casing every time the pump is pulled up and pressed down again. To prevent the grease from escaping when the gun is not in use, a long rubber hose with a patent stopper is provided.



With his hood made of tough glass, the driver can examine his motor while speeding along the road

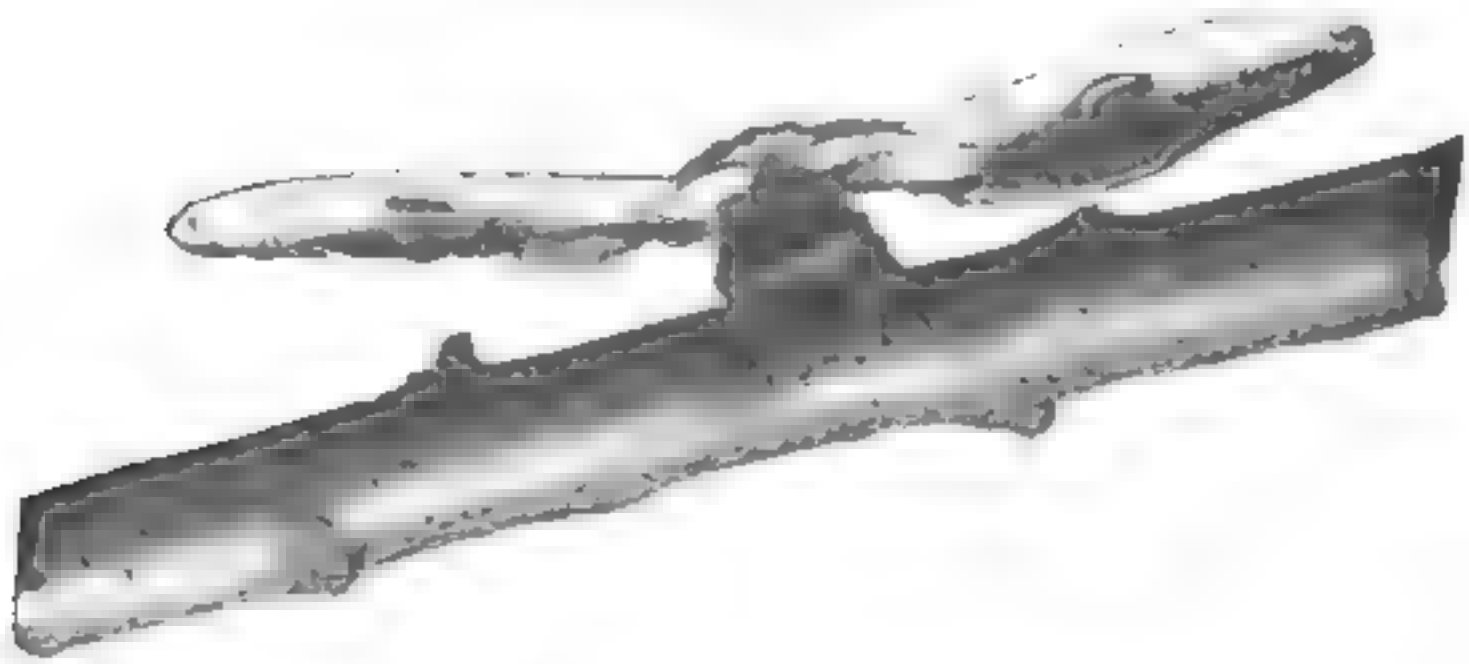
A Glass Hood for Automobiles

USEFUL and practical is the automobile glass hood built recently by Earl C. Anthony of Los Angeles, California. True, hoods of isinglass have been used, but they are easily broken and destroyed. This creator of novelties realized this fact, and as a result of his determination to eliminate this drawback came the glass "machine house."

With one stroke a quarter-pound of grease is forced into the casing

Chasing Butterflies for Money

By J. McDunnough



MORE or less periodically a lurid account crops out in the newspapers to the effect that some millionaire, usually a member of the Rothschild family, has paid a fabulous sum for a butterfly—a sum ranging anywhere, according to the vividness of the reporter's imagination, from five hundred dollars to ten thousand dollars. The effect on the average reader is either to cause a sneer of pity that anyone, even a millionaire, can be such a fool as to part with so much money for so frail and useless an object or else to create the impression that it is simply necessary to go out on the front porch or into the back yard with a hat or broom or makeshift net, knock down some unwary member of the butterfly family which happens to stray within reach, impale it on a pin in a cardboard box and ship it post haste to the aforesaid millionaire in order to receive by return mail a substantial check.

These newspaper tales seem to have a common origin in the fact that some twenty or thirty years ago an expedition to one of the islands of the Malay Archipelago was financed by a member of the Rothschild family. One of the prime objects of this expedition was to secure specimens of a large butterfly of a pure black color of which only a single specimen was known at the time. In this the collectors were perfectly successful. Besides securing specimens of the species in question, however, the expedition brought back a vast quantity of other material of great scientific value. The total expenses were doubtless considerable, probably well above ten thousand dollars; but it was not correct to assert, as it was asserted at the time, that this sum had been expended for a single butterfly. It was not spent even for specimens of a single species of butterfly.

The variety of butterflies is not as a rule due to the fact that there is actually a great scarcity of certain species in Nature, but rather because these species frequent inaccessible regions or countries. Those brilliant metallic blue butterflies of South America, the giant Morphos, generally fly in the tree tops of almost impenetrable jungles, making their capture on the wing very difficult and almost impossible; today, however, collectors armed with field-glasses search certain trees for the caterpillars which can often be secured in good numbers without any more difficulty, after they are once located, than that of climbing the tree and cutting off the twig on which the caterpillar rests. By confining these larvae in jars or cages with a sufficient supply of the food plant they undergo their transformation just as well as or even better than in a natural state. In due course of time the butterfly emerges and is thus secured in much more perfect condition than if it had been caught on the wing. As a consequence of the increased supply the price of these species has dropped tremendously during

the last twenty years, many of them being today obtainable at the cost of a few dollars per specimen. The same thing is true of the brilliant Ornithopteras of the Indo-Malay region, those huge butterflies with a wing expanse of from five to eight inches, and whose color is a combination of velvety black with either green, yellow, orange or blue. Fifty years ago in order to secure these species it was necessary for a collector practically to take his life in his hands and penetrate unknown regions inhabited by fierce head-hunting tribes; today, owing to the advance of civilization and the im-

provement in means of transportation, numbers of the species appear on the market each year; the natives have been trained to hunt for the caterpillars and breed perfect specimens of the insect, and whereas in former years collectors would regard even tattered and torn specimens as almost priceless, today for a few dollars a specimen perfect in every respect may be purchased.

In the Palaearctic region all species of butterflies from Tibet have always commanded a high price owing to the

Many butterflies are easily raised in captivity from cocoons picked off trees

The professional butterfly chaser uses every artifice in order to capture his winged prey. The time-honored net is supplemented by light at night, in order to apply practically the effect of flame on moths. An umbrella is a handy receiver for cocoons shaken from bushes

virtual impossibility of European collectors penetrating into the country; of late years, however, the Catholic missionaries who have succeeded in establishing themselves in this region have been instructed by Mr. Charles Oberthur of Rennes, France, the owner of the second largest private collection of butterflies in existence, in the capture of insects and they in turn have trained

some of their native converts. Through their agency large numbers of species which formerly were of extreme rarity or even unknown to science have been obtained.

Another region which furnishes numerous interesting and highly prized butterflies is the high mountain ranges of Central Asia, the Panier Range and the Thian Shan Mountains. Formerly species from these localities were scarcely known outside of Russian collections, but about eight years ago they began to appear on the market in enormous quantities. A Russian who had been commissioned by the Hagenbecks of Hamburg to secure live specimens of the snow leopard occupied his spare moments and those of his men in the early morning hours by picking the half-frozen butterflies off the flower heads on which they had rested over night. To judge by the quantities he secured by this method the region must have been a veritable Eldorado for the butterfly collector. As a result of his activities several species which formerly commanded a price of from ten dollars to twenty dollars a specimen became an absolute drug on the market and were almost given away.

Two Hundred Dollars for a Glittering Butterfly

Of course there still remain some rare exotic butterflies for which possibly a wealthy collector might be willing to pay from one hundred dollars to two hundred dollars a specimen, but such species can almost be counted on one's ten fingers; and it is safe to say that within the next fifty years even the price of these will be considerably reduced, for as soon as collectors become acquainted with their habits and haunts and succeed in breeding them the supply will at once increase.

In our own country, where half the indigenous species of butterflies known to science have been described within the last sixty years, there is probably no species for which more than five dollars a specimen would be paid, and the majority of species could be purchased for less than one-tenth of this sum; the rarest ones are those frequenting the desert regions of the Southwest and the great barren lands of the Far North. The inaccessibility of these regions is again the cause of the rarity, for the very fact that they have remained unmolested in their haunts by man and his civilization is proof enough that at certain seasons they should be found in large numbers.

In this connection, and as an illustration of the contention, the following story is told at the expense of one of the best known private collectors in the country. In the early eighties a collector brought back with him from Arizona two or three specimens of a new species of butterfly which he had obtained at considerable risk to life and limb by climbing some precipitous crags around which they were flying and hanging there by toes and finger nails until an unwary insect came within striking distance of his net. For years no further specimens could be obtained and finally, after making an unsuccessful trip to Arizona in search of the species our collector let it be known throughout the district that he would pay two dollars a specimen for all caught and brought to him. Imagine both his delight and consternation when a native son arrived one fine morning with over one hundred specimens of the long sought species which he had captured with the greatest ease congregated around a moist spot on the ground in some remote canyon. It is said the collector kept his word and purchased the specimens, but needless to say the offer no longer holds good.

When one considers that the number of private individuals willing and able to purchase specimens is very small and that further there are seldom any repeat orders after a small series of specimens has once been obtained, it stands to reason that as a commercial enterprise butterfly collecting is less attractive than selling clocks. On the other hand as a delightful means of spending one's spare moments it cannot be too highly recommended; the eye is trained to observe, the body is invigorated in the chase, the brain cleared of cobwebs by the fresh, pure, country air, and finally there is always the possibility of securing a little extra pocket money by the disposal of rare species which one has succeeded in running to earth.

"Once Over" and the Road Is Done

THERE has been put to work on the roads in the vicinity of Philadelphia, a new and interesting piece of road-making machinery, which is attracting attention because it performs several operations at once. After one passage

Two treatments of the roadway during the season keep it in excellent condituon

over a poorly-built or worn-out piece of roadway, the surface has been planed, scarified, rolled and left in good condition for use. The "once-over" is all that is necessary at the time. If a roadway is treated by this machine two or three times at intervals during the early part of the season it is in reasonably good shape for months of service.

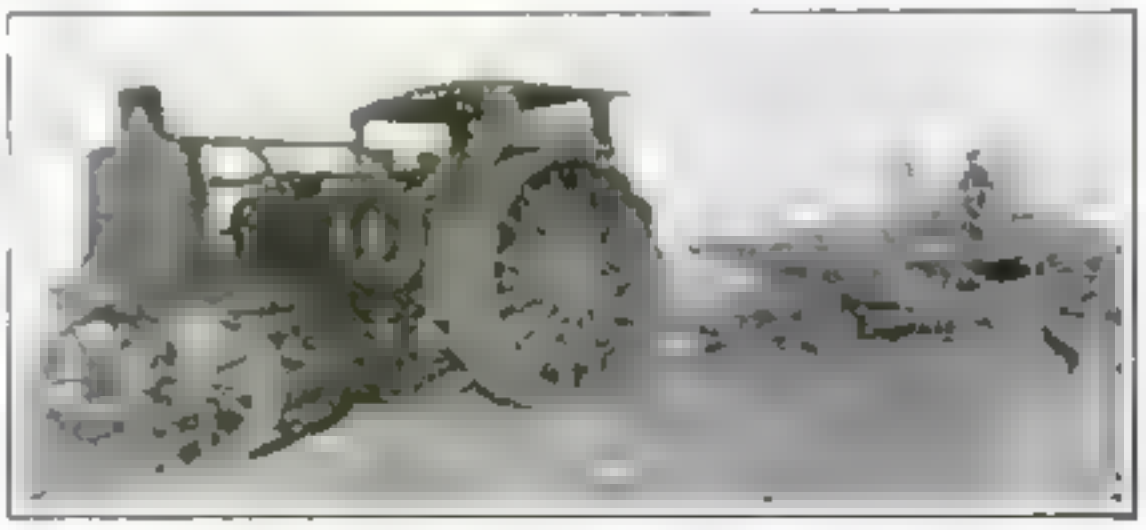
The machine, necessarily heavy, weighs about eighteen thousand pounds. It is drawn by a traction engine of from twenty-five to forty horsepower, according to the character of the work to be performed. There are two low-hanging blades on either side; as the machine passes along, these scrape off the surface of the road at the sides, bringing the loose earth to the center. The scarifier cuts off the hummocks in the center of the grade, which is then packed down hard by the action of the roller. A feature of the roller's work is that the crown of the road is as nicely rounded as if done by hand.

Drainage is essential in road maintenance, but it is impossible where there is a thick growth of vegetation at the sides of the road. Three trips over the road during the spring and early summer not only place it in good condition, but keep down this vegetation for the entire summer.

The apparatus will make a roadway thirty feet wide or may be adjusted to one-half that width. While its work is most effective in rejuvenating an old road it may also be used for building new roads in connection with an ordinary tractor-blade grader.

Some Record Dredging at Panama

THE *Cascadas*, the largest all-steel dredge in the world, which made three new high records for dredging in the Culebra Cut at Panama, can remove thirty-five thousand tons of material with ease every working day of twenty-four hours. The heaviest train ever hauled by one locomotive, from Baltimore to Philadelphia, consisted of fifty-five cars with four thou-



A traction engine pulls the machine which performs the three functions of scraping, cutting and rolling

sand four hundred and one tons of coal. The output of the *Cascadas* on one day, however, weighs more than the contents of eight such trains. Furthermore the *Cascadas* is an all-American product, designed, constructed and erected in this country by a company which is the largest manufacturer of its kind in the world.

A Fender for London Omnibuses

THE darkening of London streets, in the presence of hostile Zeppelins, has given rise to a new danger—that of being run down by automobiles. Many such accidents have already been successfully averted by a new device which is attached to the front of the automobile. Two heavy arms project forward from the axle and support a piece of wood two feet long and one foot wide, placed on end, face forward, directly in front of the wheel.

At the base of this guard is a rubber attachment, consisting of a short length of large rubber tubing, the axis being horizontal. Above is a similar piece of rubber of smaller diameter, its axis placed perpendicularly. These rubber pieces are further strengthened by curved metal pieces on their inner surfaces next to the board.

Whichever way the wheels turn, the guards remain in the same relative position, since the projecting arms are attached to the rotary portion of the axle next to the wheel. This attachment, simple as it may seem, effectually prevents running over a pedestrian by pushing him out of the way.

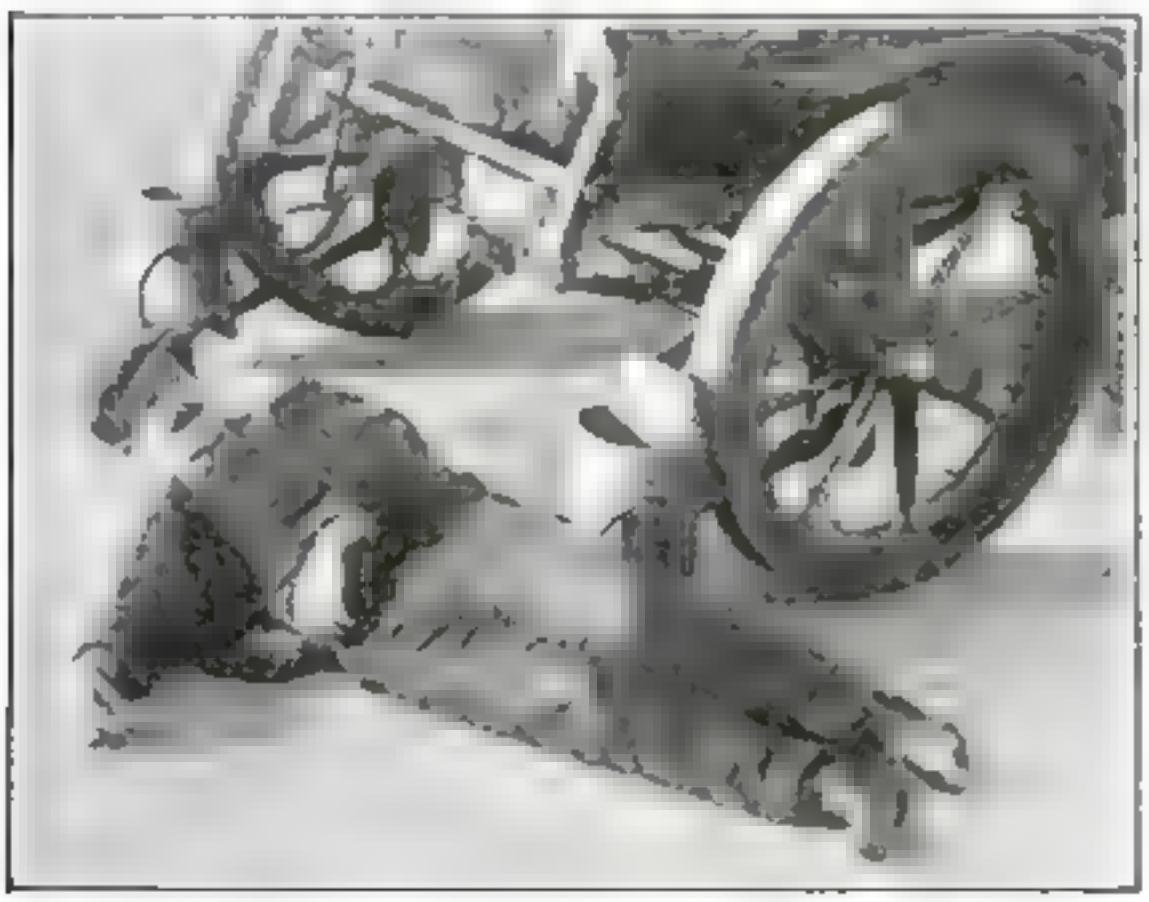
The exigencies of war have given rise to many such safety expedients. The danger from darkened streets is only one of the many problems to be dealt with. Even more serious difficulties have to be met on the continent.

A magnet tied to a string picks up clips and pins and thus saves money

He Did It With His Little Magnet

GATHERING up the fragments, as the Bible tells us, is a sure way to a life of plenty. Even so elusive and ephemeral a thing as the soap bubble is being conserved in these days of scientific management and office efficiency.

Even the office boy has heard the call of thrift, and has answered it by attaching a string to a magnet and pulling it over the office floor and pushing it into inaccessible corners, the result of which has been an acquisition of pens, pins, paper clips and numerous office accessories which would otherwise be lost.



The rubber guards strike the body and gently tosses it to one side away from the heavy wheels

Why a Featherduster Is Like a Fly

ANYBODY can see a feather duster in the hands of the housekeeper, but it takes a microscopist to discover that the fly uses a similar duster in the characteristic and amusing performance known to children as "fiddling." From its own viewpoint the house-fly is neat and cleanly, but it cares not where it scatters its dust, nor how much it inconveniences and menaces human beings. The fly dusts its body with praiseworthy industry and continuity, passing one leg over the other with a peculiar rolling motion, using each like a featherduster, and the leg being dusted as another duster.

With these featherduster-like legs, the fly spends much of his time freeing himself from particles of dust

Under the microscope, the legs, not only of the house-fly but of others related to it, are seen to be covered with hairs and bristles, which under low power, give the entire leg a feathery appearance. In some flies even the terminal claws are hairy. The fly is evidently annoyed by the dust, and much of its spare time seems to be devoted to the fiddling process. A microscopist who wants to prepare a fly for microscopical study usually allows it to develop under a bell glass, or in some other condition in which the dust cannot soil the specimen. The accompanying illustration of a fly's fiddling legs show, even under the highest power of the microscope, not the slightest particle of dust, because the fly was prepared immediately after such transformation. The purpose of the picture is to display the feathery legs in their fiddling position, free from dust. The freedom from dust is, in this instance, due to the skill and ingenuity of the microscopist, not to the diligence of the fly.

The moral of the picture: A feather duster in the hands of a diligent housemaid can spread more disease germs than a hundred flies with their microscopic feather dusters, and the mechanism is the same. Campaigns against the fly should include the duster-wielding housewife. Placards should be exhibited with pictures of a fly and a housewife and with this legend: "These two animals spread disease with their featherdusters."

Paraffin Protects the Labels of Chemical Bottles

IF the amateur chemist will paint a thin coating of paraffin over the labels of his reagent bottles with a fine brush he will be saved much time and bother in replacing labels. The paraffin will prevent any drops of reagent from attacking and badly discoloring the labels. Most reagents do not act on paraffin. The paraffin coating should extend about one-quarter of an inch beyond the edges of the label.

X-Rays and the Law

X-RAY pictures have been used as evidence in law suits brought for personal injuries in order to show the injured parts clearly. To mark the negative for identification, lead letters (opaque to X-Rays) have been used, arranged at one side of the part photographed. This method did not eliminate the possibility of fraud, and hence the photographs so marked were not always acceptable to the courts. There was no way of proving that the name and date on the picture were not forgeries. As a result some fifteen States have passed laws which prohibit the courts from receiving an X-Ray photograph as evidence unless the plate or card on which the name, address, date and remarks are written is placed either under or over the parts injured. Suppose the bones of a hand are broken and the fracture is to be photographed. It will be necessary under the law in question, to place a label directly on or under the injured part in order to make the photograph acceptable to the court. The lead letters heretofore used cannot be arranged in this manner; they hide the fracture and thus vitiate the evidential value of the photograph.

To be used as evidence in an accident case, an X-Ray photograph must have a label which could not possibly have been forged

Dr. Aurelius De Yoanna, Brooklyn, New York, has invented and patented a method of authenticating X-Ray plates which will allow him to mark the injured part and arrange a label directly on or beneath the injured part. It is impossible to "fake" the photograph. After the photograph has been taken, the fracture is distinctly seen through the label. Thus the method overcomes the objection to the lead letters heretofore employed, and at the same time the various State laws are obeyed.

The label is so pliable that it may be used on curved parts of the body and in connection with celluloid films or plates. When used with a celluloid plate the label may be placed on the plate or film or on the injured part and the X-Ray taken in the usual manner.

The label itself is made of lead, tinfoil, or any other material opaque to X-Rays, so that when written on by a pencil, pen, stylus, typewriter or other device the writing will become transparent to the X-Rays. Hence, the written or printed matter on the label may be easily read, and the fracture beneath the label carefully studied. This label complies with the law and at the same time does not injure in any way the finished photograph.

Motor-Truck's Energy Runs a Pipe-Threader

HUNDREDS of arc lamps have been transferred from wooden pole supports to the structural iron work of the elevated railway, in Philadelphia. To do this, several miles of pipe had to be threaded and cut to varying sizes. The cutting and threading work to be done advantageously had to be done as the work progressed.

Out of this necessity a novel motor-driven pipe-threader was built by the superintendent of the electric company A portable truck was equipped with a screw-cutting machine, driven by electric motor. The energy for its operation was

Current from the truck furnishes power to the screw-threading machine

furnished from the storage batteries of the truck used by the company for the transportation of men and material. The pipe-cutter was set up at any desired location, the necessary wire connections made, and it went to work. It was moved along and no time was wasted delivering pipe back and forth between the work on the street and the company's shops.

Oiling the V's on a Lathe

TO keep the V's of the lathe bed oily and in condition, a piece of heavy felt should be glued over the V's on the four wings of the carriage. The felt should be almost saturated with oil each day. As the carriage moves back and forth over the V's, the oil will spread over the surfaces in contact and emery and grit will be prevented from accumulating between the carriage and the lathe bed.

Slow-Setting Plaster of Paris

THE rapidity with which plaster of Paris becomes hard when mixed with clear water in the ordinary manner often proves to be a very objectionable feature, especially if one desires to do several little jobs with one mixing of the plaster. To overcome this fault, if the plaster is mixed with water to which has been added an equal quantity of strong cider vinegar the plaster will remain soft and workable for a very much longer time than when mixed with water alone.

Adjustable Light-Holders for Factory Illumination

ROWS of machines are peculiarly hard to illuminate economically without some such arrangement as is provided with a new adjustable holder which has just found its way into the market. By its use all machines can be lighted to save current and to prevent eyesight troubles on the part of the operator.

The new device is made of steel tubing and equipped with one or two joints which make the light adjustable. Long rows of machines, such as sewing machines, linotypes, drafting rooms, and the like, are individually lighted by standards with the globe in a steel shade, and all the wires lead to a long conduit. Where tables are not permanently established the standards can be fastened to the floor or to the walls

These adjustable light holders will solve many a difficult problem in factory lighting

For Polishing Furniture

THE polish generally used on mission furniture is the dull wax finish. If, instead of applying only wax, alternate coats of boiled linseed oil and wax are used, a polish will be obtained which is brighter and more durable than the ordinary finish.

Making the Burglar Chase Himself

REASONING that the easiest way to dispose of a burglar is to scare him with the thing he most fears, and that is a pistol, a Chicago man, R. C. Mayberry, has devised an apparatus which will fire off cartridges and do the scaring automatically at the very moment the burglar begins work.

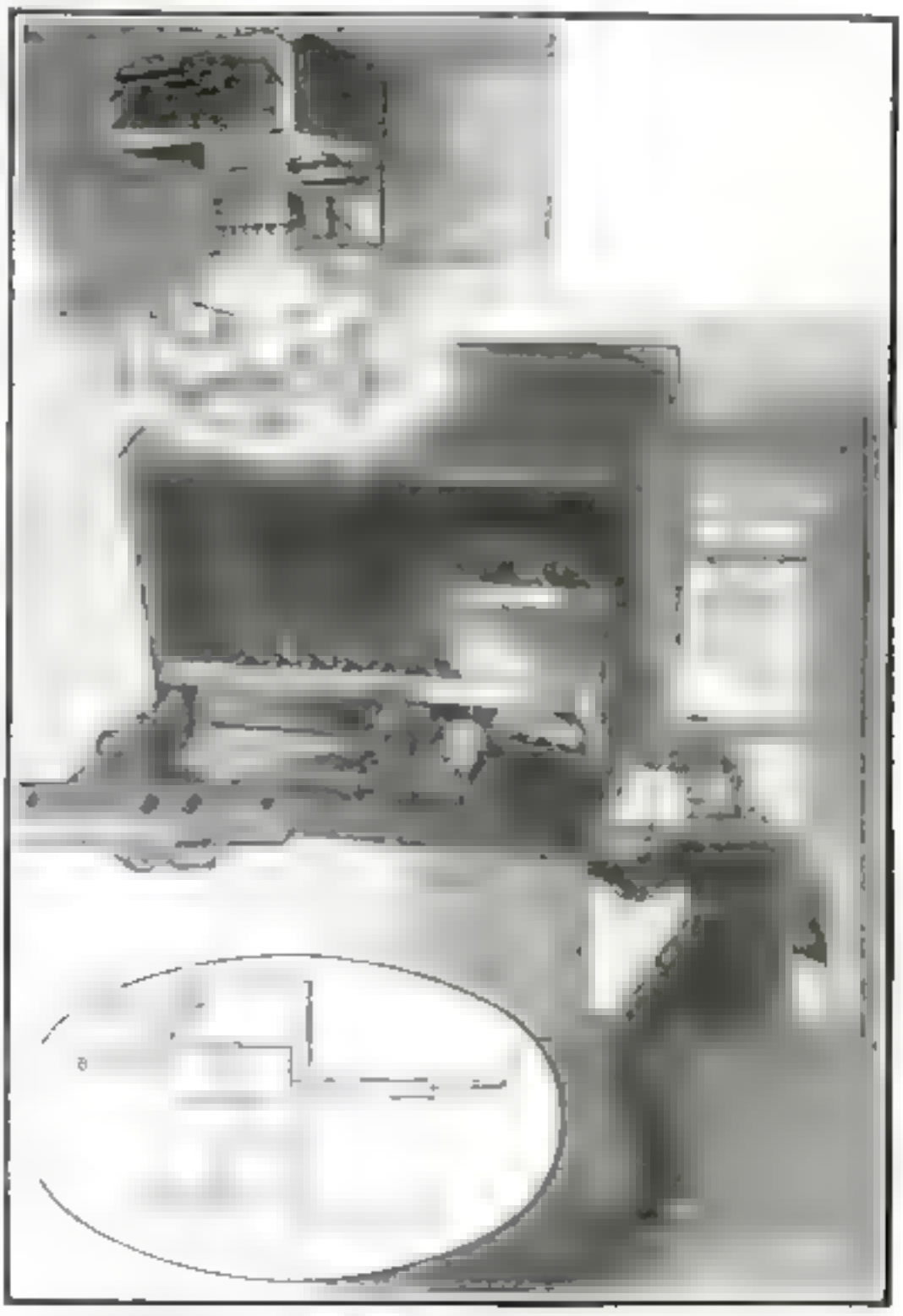
The burglar unwittingly sets off the contrivance himself and does his own frightening, as it were. This is accomplished through the aid of numerous push-buttons or other switches, located at points along the path a burglar must pursue in entering a building. Thus, the raising of a window will close one of the switches and cause the contrivance to operate. If, once inside, the burglar should stumble over a string stretched across his path or step on a loose board, a fusillade will surely greet him. As soon as he operates one of the numerous switches, his presence is promptly heralded far and wide by powder, smoke, and noise.

The device is in part mechanical and in part electrical in nature. Housed in a small box about five inches square and ten inches long, it is preferably suspended from or attached to the ceiling of a room. Hence, it is out of the way and less accessible to would-be tamperers.

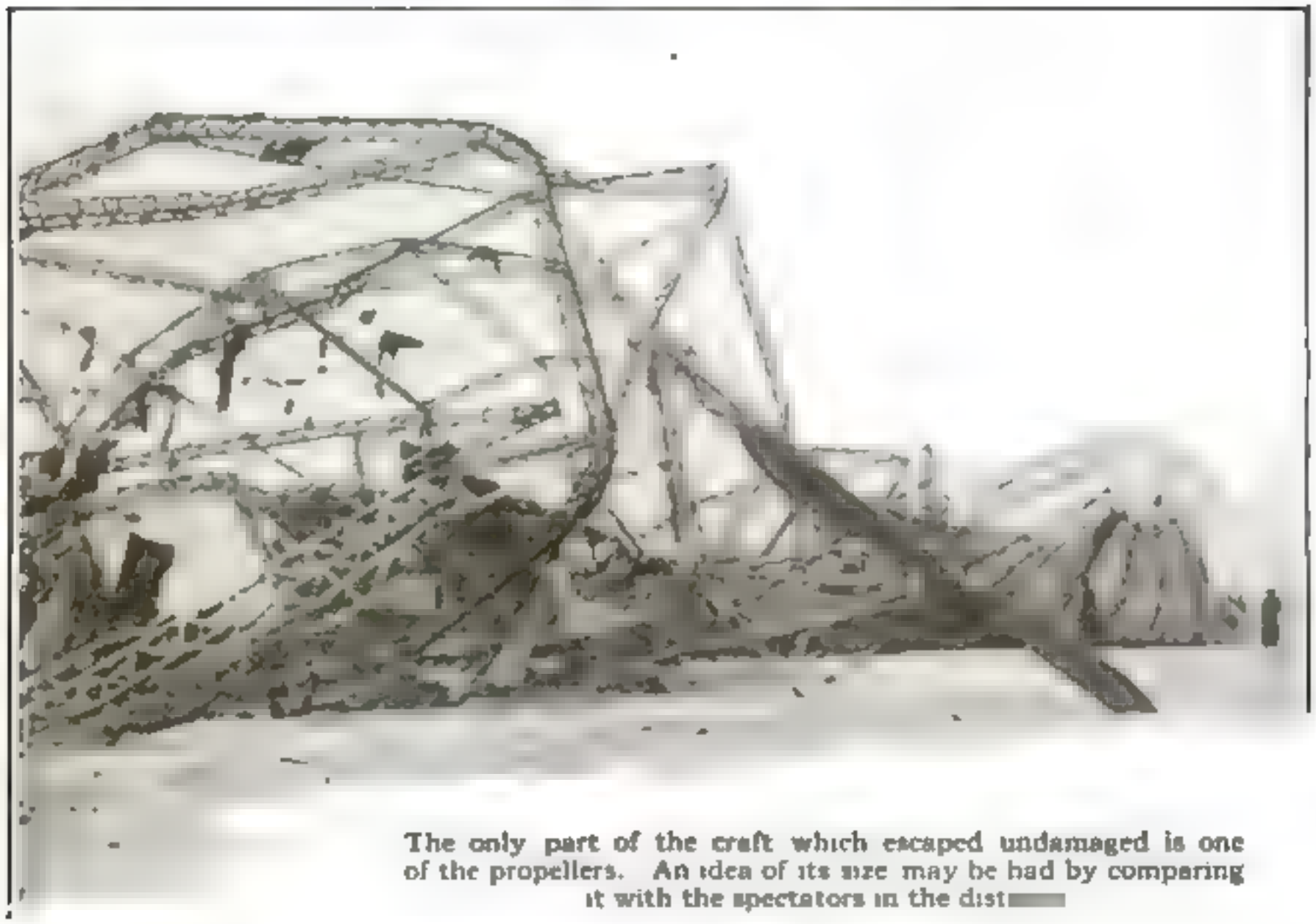
The mechanical part of the apparatus consists of a small clockwork mechanism which rings a high-pitched bell on the principle of an alarm-clock. The slow unwinding of the spring as it operates the bell, causes a cam-like contrivance to revolve, at each successive turn releasing a firing-pin on one of five .44 blank cartridges located in a metal bar nearby.

The electrical part of the mechanism comes into play in starting. The burglar's closing one of the switches causes current from dry-batteries, located within the box, to be sent through a small solenoid. This operates a small bolt-lock and permits the bottom door of the box to drop down, at the same time starting up the clockwork with its resulting exploding of the cartridges and ringing of the alarm-bell. As the bottom door drops down smoke from the cartridges escapes.

The burglar either departs before he has had any opportunity to secure loot, or else leaves so many clues behind in taking his ill-gotten goods along that his ready apprehension later is an easy matter. The robber has no means of knowing, of course, whether the shots are coming from a mechanical contrivance or from an outraged householder's revolver. He never stops to investigate.



Five blank cartridges are fired in rapid succession when the window is opened



The only part of the craft which escaped undamaged is one of the propellers. An idea of its size may be had by comparing it with the spectators in the dist

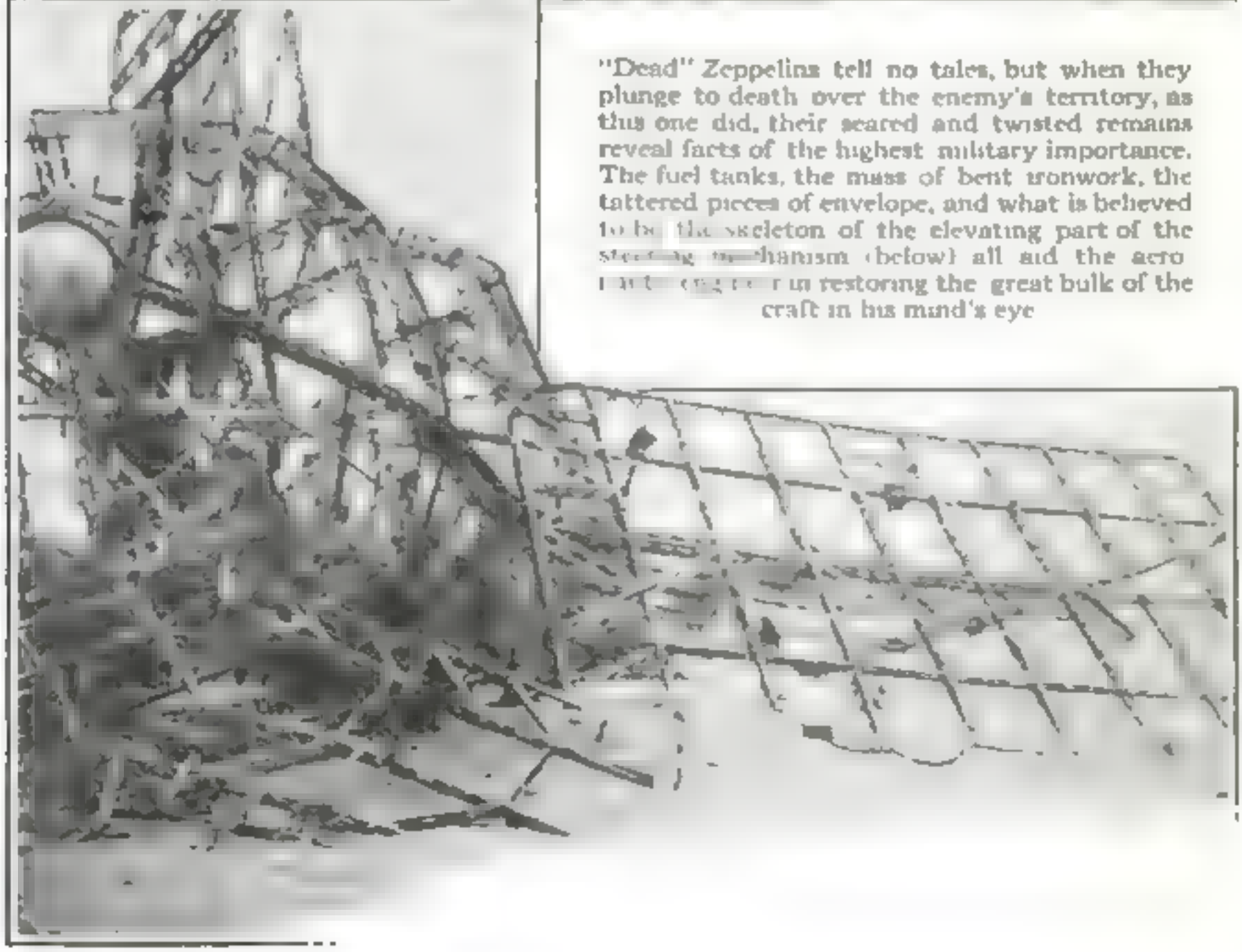
Punctured Zeppelins

"SOMEWHERE in England" there lies the mangled and crushed remains of what was once a bomb-dropping Zeppelin. In the mass of wreckage large fuel tanks, twisted network, a propeller which escaped unscathed in its downward plunge, testify mutely to its colossal size. But as to the number of the craft, the identity or size of its crew, and the location of the spot which unwittingly proved to be its grave, no one, save those in authority, knows. The hand of the censor is on the mouth of every eye witness.

As far as the actual capturing or enforced landing of Zeppelins over enemy soil is concerned the campaign waged by Germany has been a notable success. With the possible exception of the "L 77," which was brought down near Revigny, France, the Allies have little definite recent information of the construction and features of these dreadnoughts of the air. The "L 77," French discovered, possessed a fifth propeller which was attached to the stern gondola and which was driven directly from an additional engine. Hence, there were five engines in all, capable of developing a total of one thousand horsepower. The crew is believed to have numbered twenty-three men. About one and a half tons of bombs were carried. One official described the bomb-releasing device as consisting of a hook which was opened by an electrical apparatus controlled by a push-button in the central cabin of the airship. No armament heavier than machine-guns was carried.

The most recent attempt to salvage a marooned Zeppelin was made by the English when the "L 15" was forced to land off the Kentish Coast after it had been damaged by an anti-aircraft battery. After the crew had been rescued a trawler attempted to tow the water-logged airship to harbor, but the dead weight proved too much and it sank. England was thus thwarted in an attempt to examine at her own time and convenience the character of the aircraft used against her.

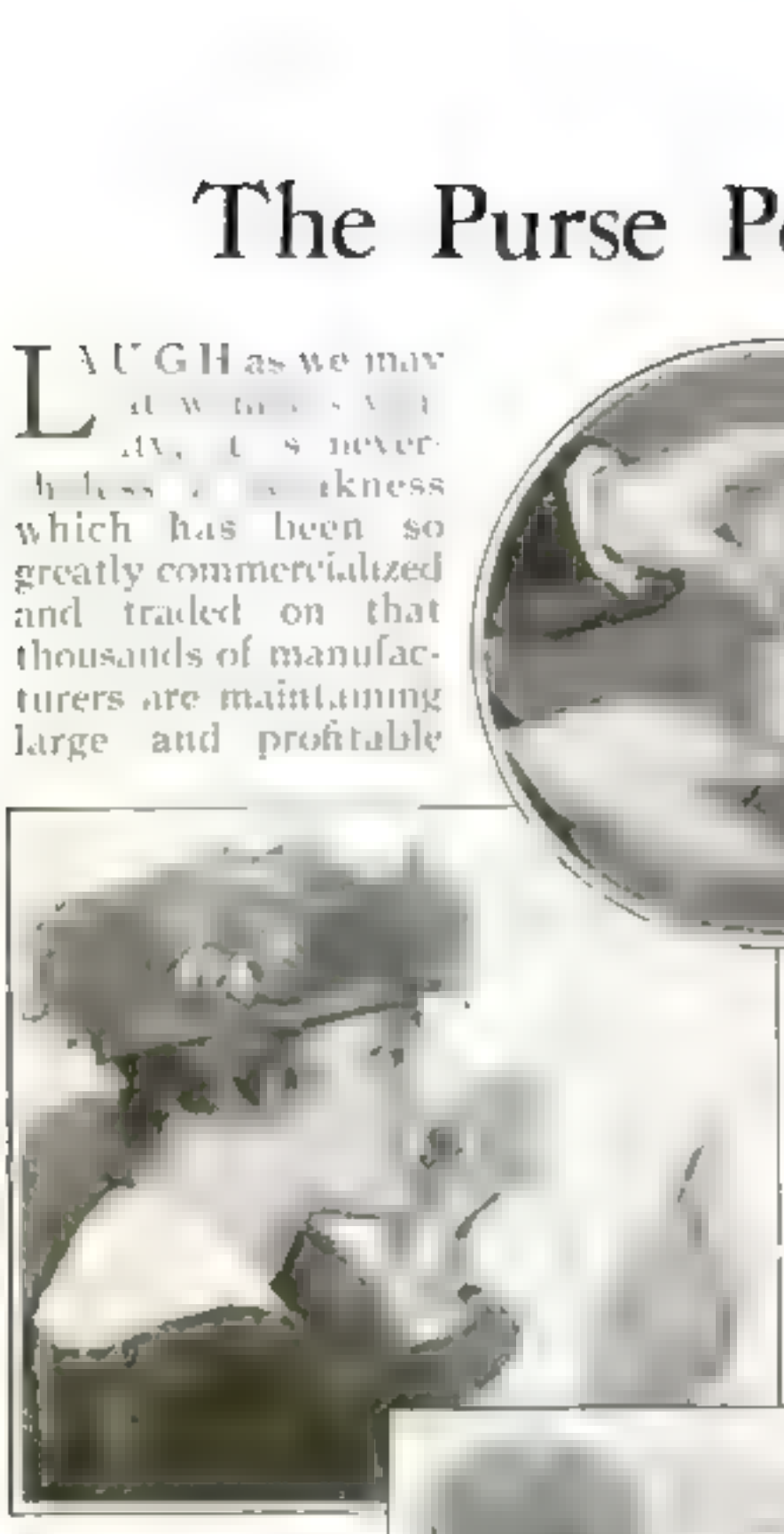
From such airships as have fallen into the Allies' hands, however, comes the information that Count Zeppelin is breaking away from the pencil form so long established by him and that he is building his new destroyers in a streamline shape.



"Dead" Zeppelins tell no tales, but when they plunge to death over the enemy's territory, as this one did, their seared and twisted remains reveal facts of the highest military importance. The fuel tanks, the mass of bent ironwork, the tattered pieces of envelope, and what is believed to be the skeleton of the elevating part of the steering mechanism (below) all aid the aero nautical engineer in restoring the great bulk of the craft in his mind's eye

The Purse Powder-Holder

LAUGH as we may at women's vanity, it is nevertheless a weakness which has been so greatly commercialized and traded on that thousands of manufacturers are maintaining large and profitable



plants solely for the making of such toilet novelties and toilet accessories as powder puffs, cases for powder puffs, mirrors, rouges of all kinds, etc.

Time was when a few women—those with more vanity or perhaps more temerity than others—carried, for the purpose of applying powder to their faces, a small square of chamois in the center of which reposed some loose powder. The rest either did not use powder or, if they did, dabbed it on their faces only in the privacy of their boudoirs. This method was unsatisfactory and inconvenient; the loose powder was spilled and wasted as it was applied. An ingenious and far-seeing manufacturer then put on the market a small, round, cotton or wool contrivance which was used in connection with the square of chamois and loose powder. A decided improvement, this proved a boon to the fastidious lady who wished to repair the ravages of an afternoon's shopping to her complexion before she reached home. Still, its use also entailed waste of powder as well as the inconvenience of carrying about on one's person a bulky package from which the powder persisted in leaking into the purse or pocket where it was carried.

At last a very compact and useful little novelty has been invented which not only combines facilities for carrying powder, but also provides compartments for the mirror and hairpins, so necessary in fastening veils, stray locks, etc.

This compact little case contains a mirror and hairpins, besides the chamois powder-puff. The powder cannot spill out of its container, yet it is always ready for use

Half of the little case is made in a pocket form to hold the powder, with a small opening at one side which is closed with a clasp. The inside of this half—that is, the side applied to the skin—is made of chamois slashed or perforated so as to permit the powder to sift through easily but without waste. The other half, which folds directly over the puff side, serves as a preventative for the leakage of powder and also provides three little compartments, one large one for a mirror and two smaller ones for hairpins. When not in use both sides are held together with a clasp fastener, so it makes a flat and compact arrangement which may be very easily carried in the purse or pocket.

Hazards of Motion-Picture Acting: Real and Faked

By E. T. Keyser

SOME people maintain that a camera will not lie. They are correct. A camera shows exactly what happens; but if you place the wrong construction upon what you find in the picture that is entirely your own fault.

If, in a screen comedy, an automobile proceeds casually to ascend the front of a skyscraper, don't miss the remainder of the reel by rushing to the box office to enquire the make of the machine. Perhaps it has not such a very good hill-climbing record after all. Had you watched the filming of that particular scene you would have observed that a representation of the skyscraper's front elevation reposed flat on the floor and that the automobile traveled over it in the usual manner, while, above it, and with lens pointed downward, the motion-picture camera was recording the fact.

A most wonderful exhibition of athletic prowess, as evidenced by a swimmer's ability to jump from the water to a springboard ten feet above, was produced by the simple method of having the aquatic Samson run backward along the board and jumpoff backwards. Then the film was run through the projecting machine reversed, presenting indisputable evidence that the flying fish of the tropics had found a human rival

Speaking of jumping, have you noticed the effortless manner in which comedy characters lightly vault to the top of a wall which would have baffled the crack pole-vaulter of your old college team? The actor is photographed while making a short jump from the ground. The cameraman ceases grinding while the jumper ascends the wall via a ladder, placed out of range of the lens. Then the actor jumps down. The second "take" is reversed and joined to the first, thereby showing the superiority of knowledge to training.

But it is not in comedy alone that the ingenuity of the cameraman and of the cutter is shown. Nellie, the little daughter of the engineer, wearied by a long day's quest of the elusive buttercup, goes to sleep on the railroad track, with her downy cheek pressed close to a fish-plate. Papa, driver of the crack flier, with the Limited in tow, rounds a curve and sees with horror his angel in the path of the iron monster. To stop the train is impossible. Must Nellie die! Perish the thought. With an agility bespeaking long practice in saving little Nellies, papa climbs forward on his engine, reaches the cow-catcher and, just as its cruel bulk is about to crush out the fair young life, leans over and triumphantly raises his child in his strong right hand and out of harm's way.

Helen Gibson playing the leading role in a breathlessly exciting railroad drama

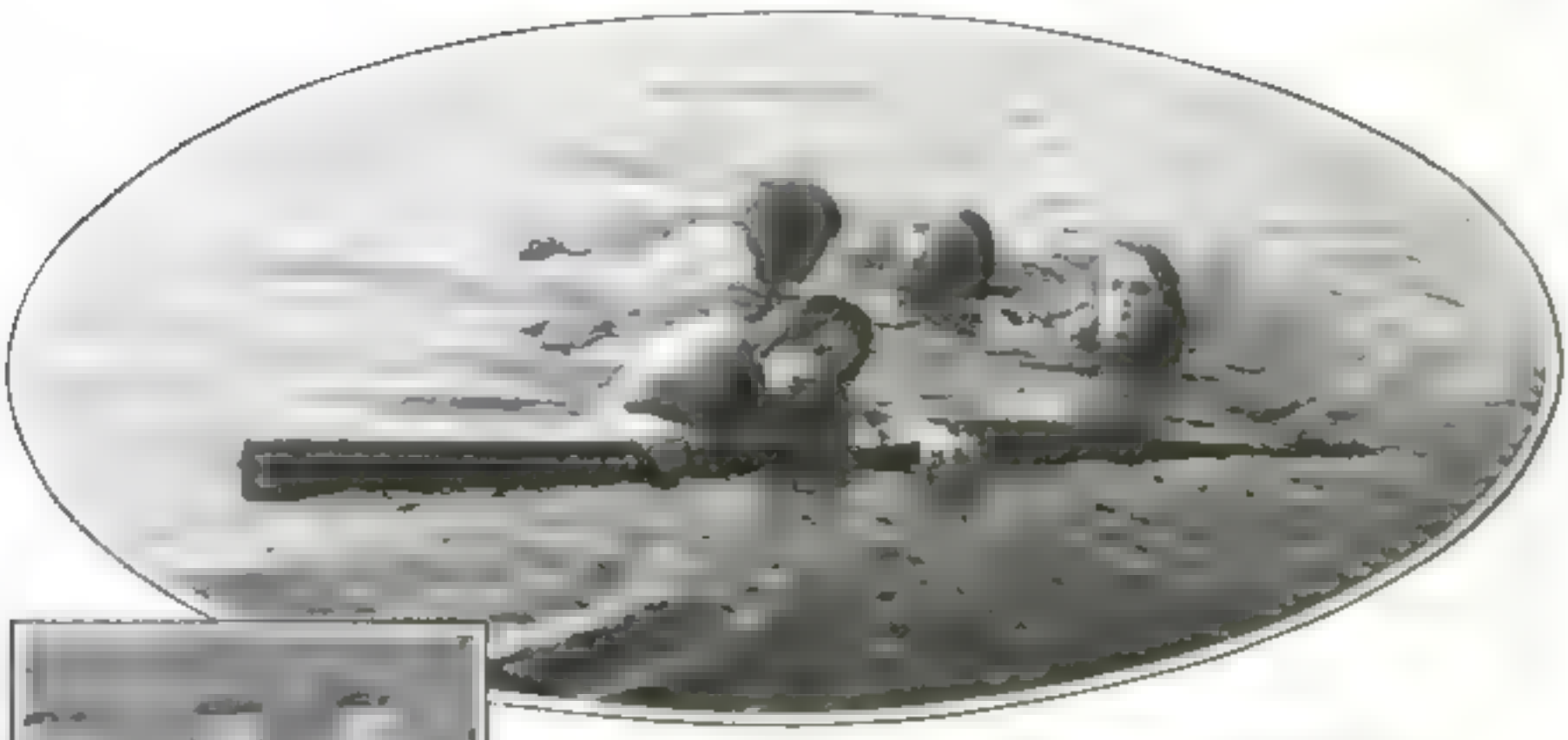
Before complaining to the S. P. C. C. of the reckless manner in which children's lives are

The cold shudder caused by witnessing a death struggle on the edge of a precipice, with the final thrust which hurls the villain into space, has no basis in fact. Just as he is about to fall, the camera is stopped, a dummy substituted and the action resumed. As soon as the dummy is spattered on the rocks below the camera is again stopped and the real man assumes the position of the dummy Mark Swain and Chester Conklin are here shown about to fall from a real aeroplane in this safe but photographically horrible way

When the picture in the circle is viewed on the screen, it will tell the story of a hair-breadth escape from destruction, but when it was enacted, the train was moving very slowly and the daring leap was made with deliberation

Above, a leap for life
This jump was not faked

A wrecked bridge makes a good setting for a film story



Above, a real water scene. Ability to swim and dive is invaluable to the moving-picture actor. In some instances, the "struggle for life" which appears on the screen is not faked. Below, a horrible train wreck from which some cherished heroine miraculously escaped

Above, jumping from a burning building into a net. Below, Pearl White rescued from drowning

In circle, Helen Gibson, former telegraph operator, and Robyn Adair "playing" on a railroad bridge

Douglas Fairbanks has forsaken the regular stage for such dare-devil "stunts" as this

endangered to make a few feet of film, come and watch how it is done. Behold the locomotive with the engineer on the cowcatcher, Nellie in his arms. Observe that the train is moving slowly backward and that the camera man is grinding slowly. Papa lays Nellie carefully down on the track; then walks backward to his cab. When the film, reversed, is run rapidly through the projector, there will be another thriller on the screen.

[N. B.—It is now considered advisable to use hard coal when doing this feat, since a keen observer in the audience once noted that the clouds of smoke were pouring *into* the stack instead of out of it.]

Did you ever notice the realistic manner in which a screen motor-car will bump its victim? It is so natural that you would imagine yourself witnessing an actual occurrence at Fifth Avenue and Thirty-fourth Street while the traffic policeman's back is turned. There are several methods by which the operation may be performed without losing the bumpee's services for the next picture. The victim may lie down in the road, right up against the front tires and the car is started on the reverse with a most natural jump. Then the cameraman ceases turning while the car is brought to the other side of the prostrate one, with the back of the rear tires touching him this time. Quick throwing of the lever into speed forward produces another jump. The whole performance looks very tragic when it gets on the screen.

Another method is actually to bump and push the victim over and then to pass over him at slow speed with the camera-crank also turning slowly. A rather spare style of architecture is preferred in the victim of this method, as clearances must be carefully considered.

But it is not all trick work, however. There are actors of the screen whose artistic sense or pure dare-deviltry causes them to yearn for a realism which lands them alternately in the Hall of Fame and the hospital.

Some time ago, Irving Cummings worked in a picture which called for a close crossing of an automobile and a railroad train. Picking his crossing, he timed a particular train from a given point to the exact spot selected for the crossing. Then, with a stop watch, he timed his car, from a start from which he could view the train reaching the fixed point. He averaged train and car for several days. At last he made

Helen Gibson makes a safe landing on a horse from a crane on a moving wrecking-train

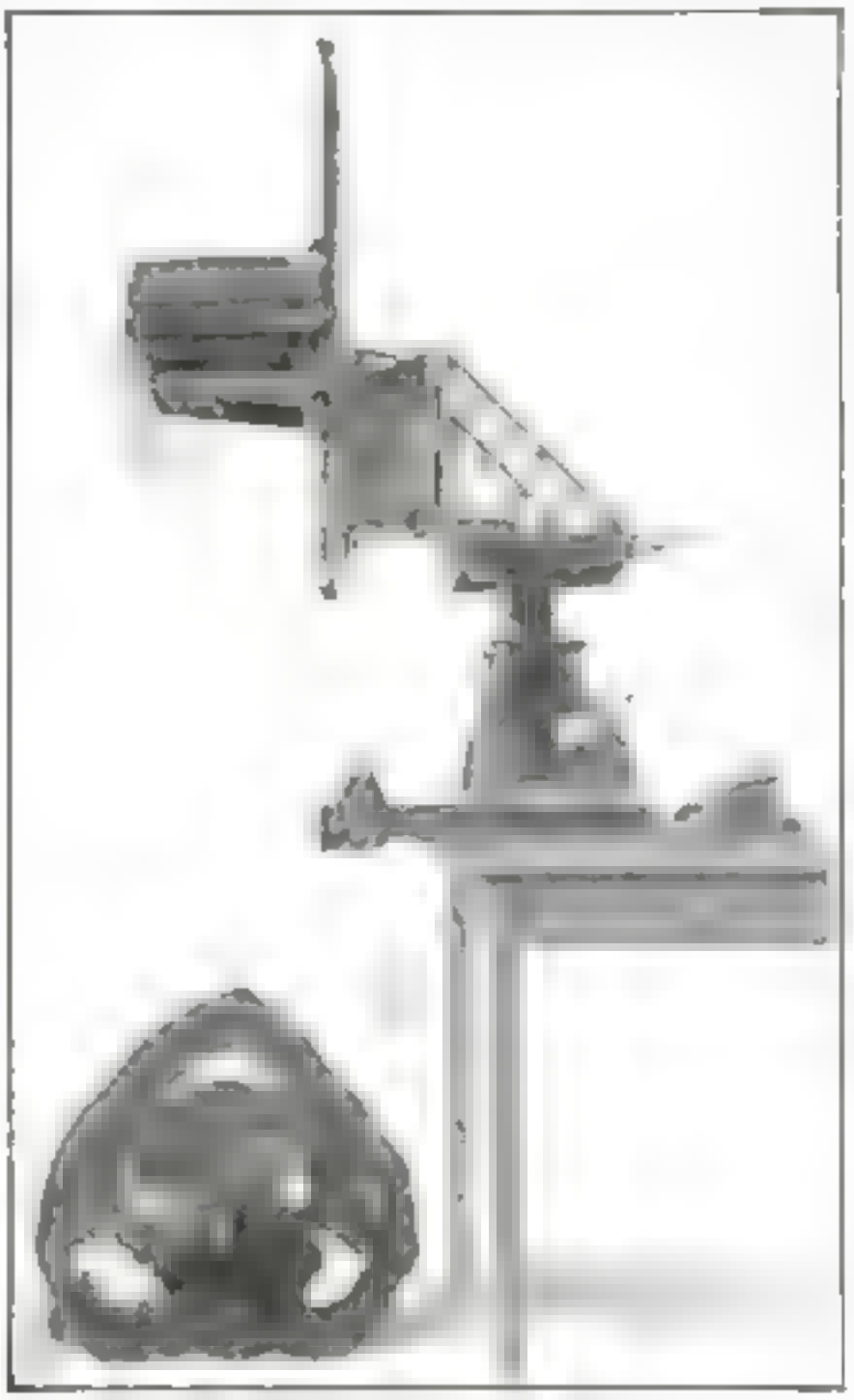
the dash. There was enough accuracy in his arithmetic to get the crossing but he left part of the rear mudgard aboard the cowcatcher. The engineer, who was the only extemporaneous actor in the event, took a week off at the picture company's expense to recover from the shock.

Not so long ago Anita King, in "The Race" went off the end of a broken bridge and twenty feet out into the water, while an officer was waiting in the Hollywood studio to serve an injunction upon her to restrain her from carrying out the performance. Some one who had received a tip of what was to happen and who feared for the actress's safety had made a strenuous effort to prevent the hazardous leap.

Elmer Thompson has just jumped his car across a twenty-seven-foot gap in a bridge out in Camarillo, California, in the taking of a scene for "The Secret Submarine." The car lighted on the forward wheels with the rear ones elevated like the hind legs of a bucking broncho. It was touch and go whether the machine would somersault or right itself. It happened to do the latter.

In "The Trail of Danger," Helen Gibson is swung by the derrick of a rapidly moving wrecking train, from the saddle of a horse, to the deck of one of the cars.

This combination of cameraman, cutter and realistic actor is responsible for more thrills on the screen than can be found in any three-ring circus, outside of the posters. The life of a moving-picture actor is a series of thrills.



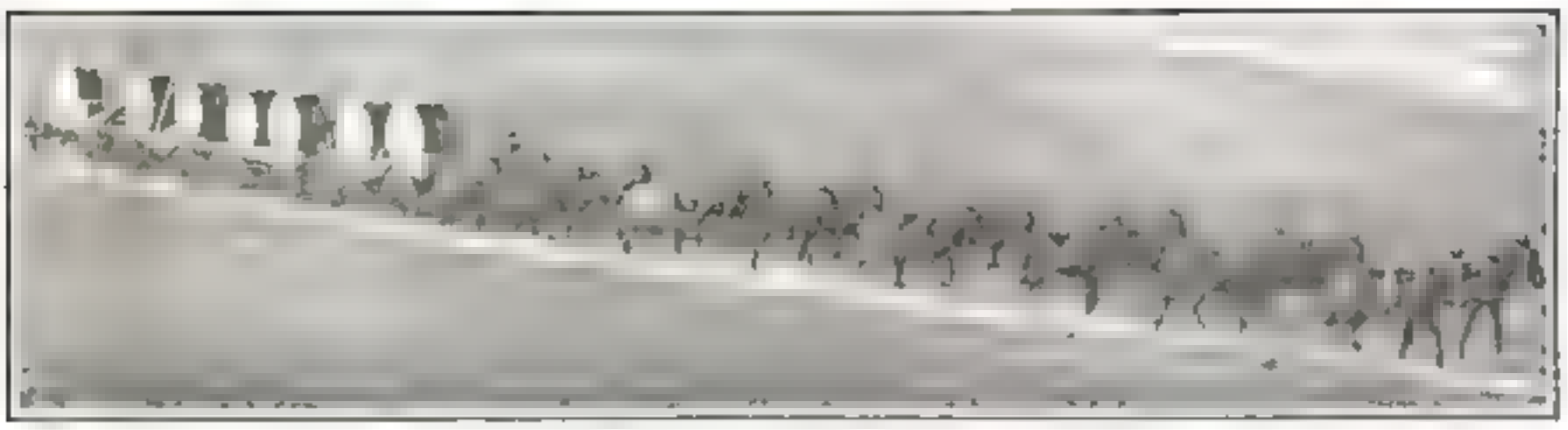
Sometimes a fossil skull weighs a quarter of a ton; it cannot be lifted to be photographed. That is one reason why this camera was invented

A Camera Which Can Be Tilted At Any Angle

IN photographing natural history objects such as skulls, mounted fossils, etc., it is often necessary to take a view of the specimen as seen from above. In most cases the object can be taken off its stand and placed against a vertical screen with the side to be photographed toward the camera. Sometimes, however, the object is so delicate that one dare not turn it from its upright position, or it is too valuable to risk handling, or it may be altogether too large to do so, as for instance in the case of a dinosaur skull weighing a quarter of a ton or a completely mounted fossil animal.

For such cases, there is in use by Mr. A. E. Anderson, photographer to the Department of Vertebrate Paleontology of the American Museum of Natural History in New York, a camera of his own design, which can be tilted at any angle, or, in fact, turned upside down, as shown in the illustration. The camera has a ground glass eleven by fourteen inches and is provided with an unusually long bellows. The stand supporting it is so constructed that the camera when turned upside down can project a considerable distance beyond the vertical axis on which it ordinarily rests.

With the aid of this camera, Mr. Anderson has found it possible to photograph anything which presented itself, whether it was too heavy to be lifted or too delicate to be moved.



Four four mule teams are more efficient when pulling together than when separate where extensive transportation is necessary. The maximum traction effort required is less than four times the maximum for a single team

Expensive Transportation

IN many engineering projects, the cost of transporting equipment and materials assumes a very high relative value.

In illustration, may be cited the case of the hydro-electric development of Big Creek in California. The site of the works was to be located fifty-six miles from the nearest railroad. It was estimated that to do this work with teams, the transportation cost would have been about twenty dollars per ton. So, the contractors built a standard size railway.

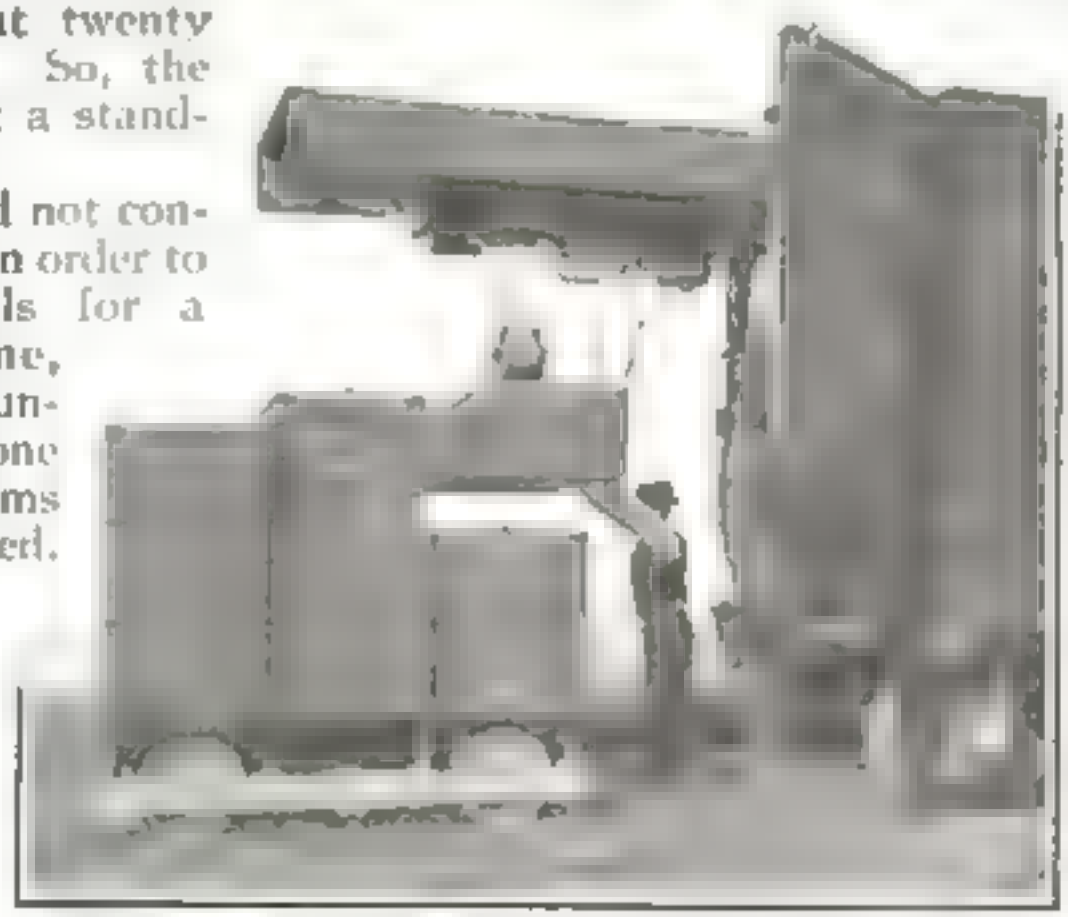
But they could not construct a railway in order to supply materials for a transmission line, which is two hundred and forty-one miles long. Teams had to be employed.

A little consideration will make clear why it is better to unite four four-mule teams into one than to use them separately. A loaded wagon must ordinarily be hauled by a team able to overcome the maximum difficulties. A string of four wagons would hardly all of them have their individual maximum difficulties at the same moment. In other words the maximum traction effort required for the string is probably less than four times the maximum effort required for a single wagon.

A Traveling Laboratory for Testing Railway Scales

ONE of the interesting phases of the United States Bureau of Standards' work is the testing of railway-track scales by means of traveling test-cars which make their way over the great railway systems of the country.

Two test-cars are now engaged in this work. Each test-car carries ninety thousand pounds of standard weights, eight of ten thousand pounds each and four of two thousand, five hundred pounds each. The car carries also a small truck driven by an electric motor on which the weights can be placed so as to be rolled on to the trucks of the scale to be tested.



The test-car is used for detecting faulty railway scales

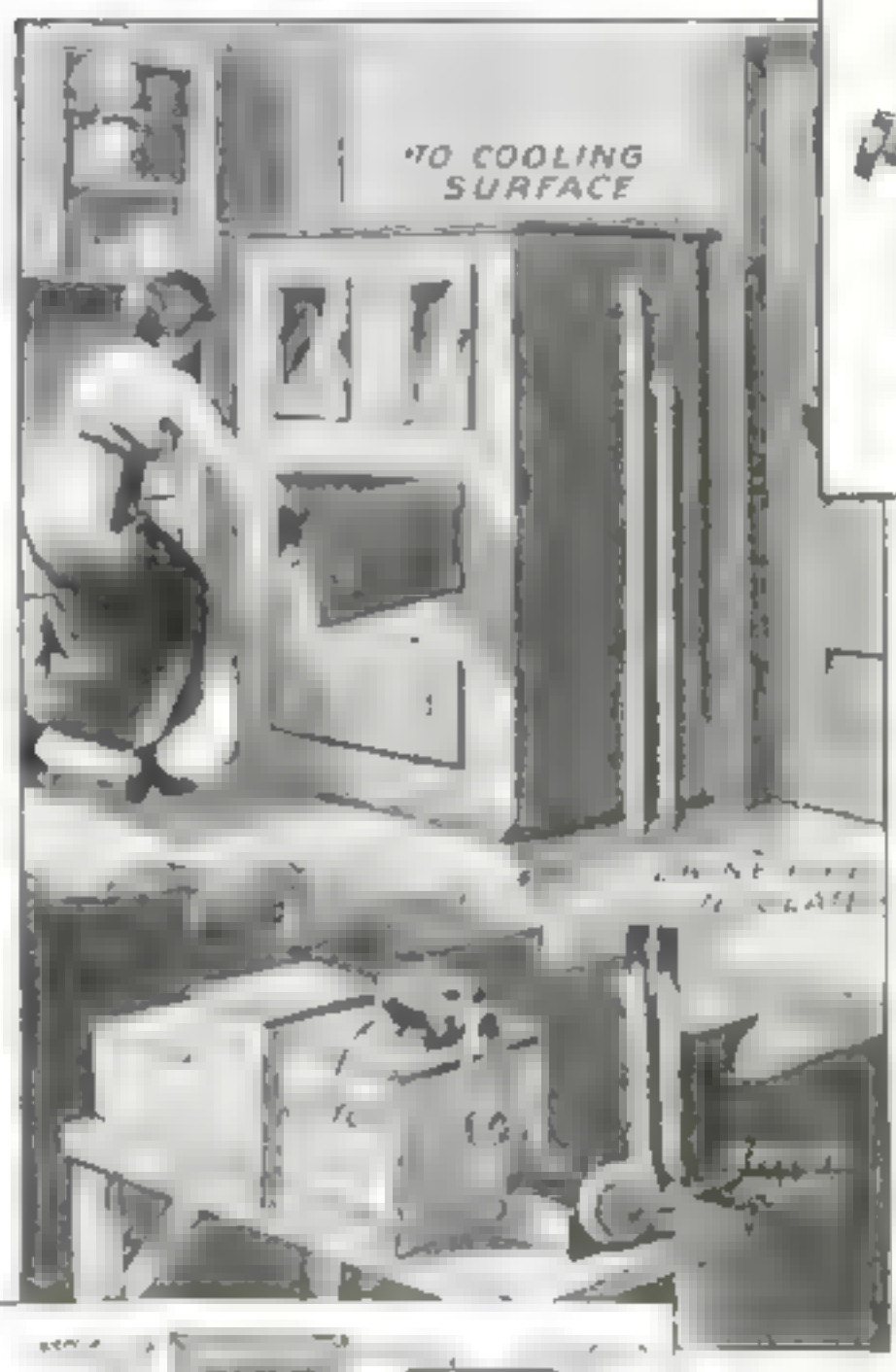
At the forward end of the car there is a crane which can be extended through the end doors, and which carries an electric hoist for raising the truck and placing it on the track. The work of the first test-car demonstrated that seventy per cent of the number of freight scales tested showed an error of at least two hundred pounds in weighing a freight car of one hundred thousand pounds. This proves that the test-car was needed.

Ice Making at Home

By Jay F. Bancroft

THERE is no sound scientific reason why a household refrigerating machine should not be a commercial success and go into very general use in private homes. There is a wide demand for such machines, and much money and engineering skill have been expended in their development. Notwithstanding this, it must be admitted that they have not gone into use very extensively in private households.

The use of refrigeration to cool and preserve our food and drinks is so general that it has now come to be regarded as an essential factor in our daily life. Nevertheless it is surprising how few users of such refrigeration there are who could accurately explain even the principles on which the ice-cooled refrigerator works. Everybody knows that in order to cool a substance it must be placed in proximity to a cold body, such as ice. There are numerous ways in which cold bodies can be produced mechanically, but the only way in practical use in household refrigerators is by the evaporation of a liquid. If the hand is plunged into warm water and then exposed to a draft of air the hand dries, but also becomes very cool. This cooling effect is more pronounced if ether or alcohol is used instead of water, for such liquids evaporate more readily. The cooling effect is due to the fact that the liquid has changed to a vapor, and in doing so has absorbed a perceptible amount of heat from the hand, which heat disappears with the vapor. This principle is extensively used in dry climates for cooling water which is placed in porous-walled vessels exposed to the air. The small amount of water that seeps through the porous walls and is evaporated will cool down the remainder of the water within the vessel.



The refrigerating apparatus here described can be conveniently located in the basement below the kitchen. The principal feature of this machine is thedumb-bell container shown in its relation to the other parts of the machine. This machine is so nearly automatic that the services of an expert attendant are not necessary

Should water be placed in a pan under the receiver of an air-pump such water can be very much cooled, or even converted into ice, by removing the vapor as fast as it is formed. Only a small fraction of the liquid is evaporated, but in the evaporation of this small fraction a

In ammonia machines, high pressure is avoided by means of an automatic switch which stops the motor

large amount of heat is absorbed from the remainder of the water, which is thereby cooled to the freezing point. This heat apparently disappears in the vapor, for the vapor is no warmer than the water from which it comes. This heat is said to be latent. Now should the pan containing the cooled water be connected with a pipe-coil located in a refrigerator, the cold water would perform the same function as ice. In practice, however, water is not used in refrigerating machines, more volatile liquids being used instead; the vapor discharged by the pump is condensed and returned to the evaporator to be again evaporated.

Of the several well-known types of refrigerating machines, the gas compression and expansion machine is the one most generally used for cooling household refrigerators. All compression machines are made up of four distinct parts, viz.: a compressor or pump, a condenser, a refrigerating-coil, and an expansion valve between the condenser and the refrigerating-coil. These are connected in a closed cycle so that the compressor can suck out the gas from the refrigerator-coil and discharge it under high pressure into the condenser, where the hot gas is cooled by running water. The combined effect of pressure and cooling causes the gas to liquefy. This liquid passes through the expansion valve into the refrigerator-coil where it evaporates because of the low pressure maintained by the suction of the compressor and the heat absorbed from the articles being cooled. The function of the refrigerant is that of a heat-carrier; it takes up heat in the refrigerator and discharges it into the cooling water. It is able to do this by reason of the work of the compressor which maintains a high pressure in the condenser, where the heat is discharged, and a low pressure in the refrigerator-coil, where the heat is absorbed. The refrigerants most generally used are ammonia, sulphur-dioxide, and ethyl-chloride.

The most essential requisite of a household refrigerating machine is that it shall be so nearly automatic that the services of an expert attendant shall not be required.

A near approximation to this requirement seems to have been attained by the machine shown on page 891. The larger of the two hollow shells encloses the compressor, and the shell itself is the condenser and runs in cooling water, while the smaller shell acts the same as a refrigerator-coil. When completed this device is charged with a suitable amount of sulphur-dioxide and lubricating oil and is then sealed up. As all the moving parts are sealed up, the escape of gas is effectually prevented. By reason of the ingenious manner in which the compressor is constructed all danger from high pressure is overcome.

The illustration on the preceding page shows how this machine may be used to cool a refrigerator on the dining-room floor of a home, the machine itself being in the basement.

While ammonia is a most excellent refrigerant in large machines, it is not much used in household machines because of the danger of the high pressure in the condenser and the possibility of leakage. Ammonia machines for household use are usually so arranged that the switch controlling the motor is closed by the pressure of the water flowing to the condenser, and whenever the water fails or is turned off the machine is automatically stopped. In this way dangerously high pressures in the condenser are avoided. In all ammonia machines the pressure in the condenser

weaken the metal walls of the still, which in time will cause leakage of ammonia-gas.

It may be said that any compression machine can be used with any volatile refrigerant that will boil at 30° F., or under, when exposed to the atmosphere, but in practice certain minor differences are observed in the construction of the machines on account of the differences in pressure of the various refrigerants used. Inasmuch as all the machines above referred to are practically automatic, and can be run, and are being run, without a skilled attendant, it is hard to understand why such machines are not more generally used.

An absorption machine, though expensive to install, ought soon to repay the initial cost

The high cost of the first installation is probably the largest obstacle to their very general use. Take a machine whose first cost is $900 and whose life is, say, ten years, you have a fixed charge of about $12.00 per month. Add to this the cost of electric current, and the cost of whatever repairs and adjustments may have to be made by skilled experts during the life of the machine, and you have a bill considerably in excess of the cost of 100 pounds of ice per day.

One of the most objectionable features urged against compression machines is the noise made by the motor and compressor. Even when the machine is located in the basement it can be heard over most of the house, and at times such noise is deemed very objectionable. Another cause of trouble is in securing a constant and even flow of cooling water to the condenser, where constant running cooling water is used. In many places the water supply contains sediment or dissolved minerals which will tend to collect under the controlling valve and diminish the flow of water.

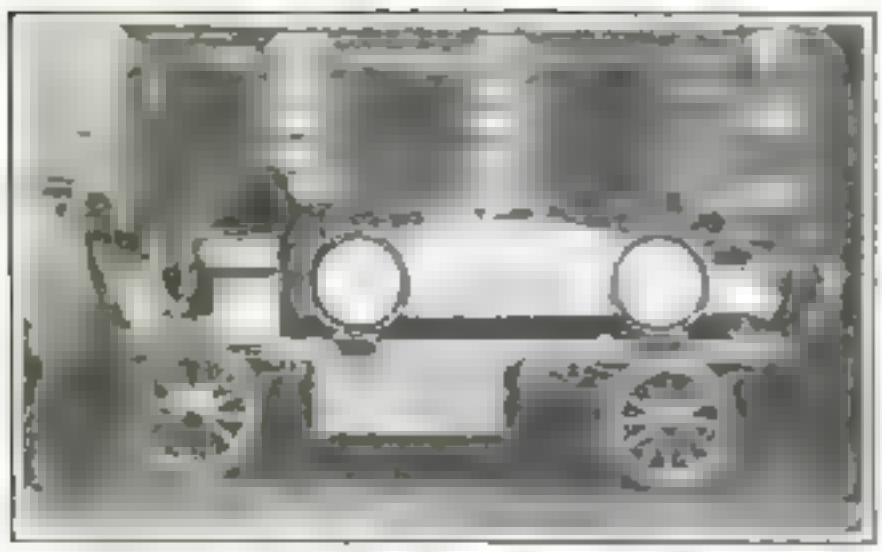
Most people imagine that the temperature in an ordinary ice-cooled refrigerator is lower than it really is and when they install a refrigerating machine they try to keep the temperature down below 40° F. The insulation in the ordinary refrigerator is not sufficient to maintain such temperature and hence the use of electricity to run the machine will be excessive.

When the public is fully aware of the great advantages, sanitary and otherwise, of this character of cooling, over the ice-refrigerator plan, the difference in cost, it is believed, will be cheerfully accepted.

The actual cost to build a machine of this character that sells for $900 is probably not one fourth of that amount. It is fair to presume that the first cost price of all these machines will soon be materially reduced.

Unfortunately, several machines have been put on the market which were faulty in design and involved engineering defects which made their failure a certainty, and these failures have cast a shadow on the really meritorious machines.

All the difficulties and obstacles tending to prevent a commercial success of these machines are apparently capable of being overcome by engineering skill.



The "Torpedo Kid" was modeled after a falling drop of oil

An Electric Automobile Built Like a Drop of Oil

OUR present day pear-shaped racing automobiles are all distant cousins, so to speak, of the "Torpedo Kid," a car designed by Walter C. Baker, the creator of the first American-made electric. In a dash at Ormonde Beach, Florida, some years ago, it did a mile in 56 seconds, establishing a world's record for speed at that time.

Oddly enough Mr. Baker came to be the originator of the first pear or cigar-shaped racer by studying the shape of a drop of oil as it fell through the air. He observed that the drop, while falling, was not round but took the form of an ellipse. In short time he arrived at the conclusion that a solid body of the same shape as the drop of oil, if cut in two and built low to the ground, would offer the least possible wind resistance. He followed out this theory in the construction of the "Torpedo Kid," and its initial record of a mile in 56 seconds proved that Mr. Baker was right.

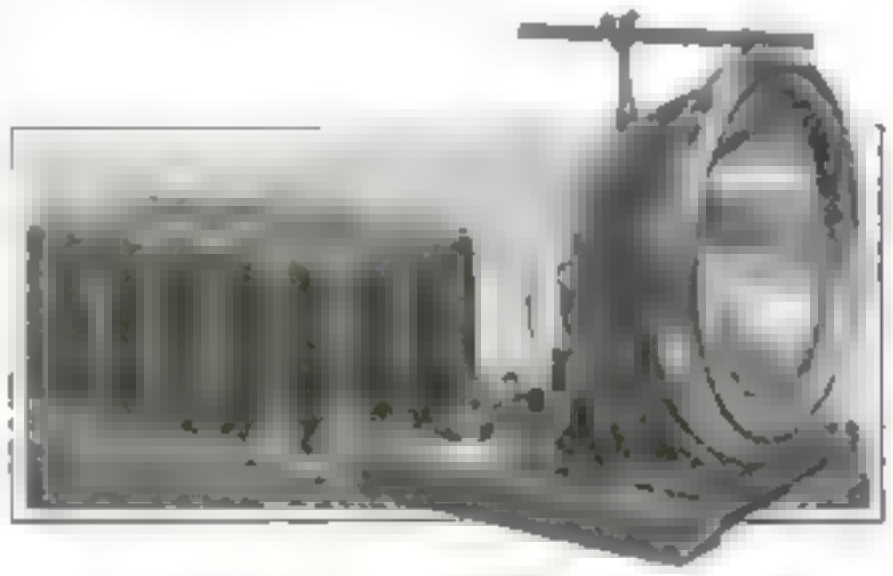
Other automobile manufacturers were quick to see the advantages of the constructional features embodied in the "Torpedo Kid," with the result that pear-shaped racers, electrically and gasoline-propelled, began to dot the courses of our race tracks. For a while the electric racers held their own against the others, but the gasoline engine improved so rapidly that before long the electric racer was as scarce as it was before the heyday of the "Torpedo Kid." However, Mr. Baker has built a larger car along the same lines as his speediest electric, and it is said to have made one hundred and twenty miles an hour. A few years ago it was entered in some races in France but before it could give account of itself, it got beyond the control of the driver and ran amuck, injuring several bystanders.

Signaling Three Hundred Miles

A PORTABLE electric signal-light which, although operated by dry-cell batteries, gives two hundred and fifty thousand candlepower, has been designed and constructed by E. G. Fisher, chief of the instrument division of the United States Coast and Geodetic Survey. It is to be used during the summer in the mountainous regions of Idaho and Oregon on primary triangulation where the distance between stations is frequently as much as one hundred miles. No larger than the ordinary automobile head-light, the packed apparatus weighs about twenty-three pounds. Under ideal atmospheric conditions the light will be visible through a telescope of ordinary power for a distance of two hundred and fifty to three hundred miles.

The great power of the light is due to a new type of tungsten filament designed by Mr. Fisher. The filament is concentrated so as to confine the light to as small a point as possible—very much as in the gas-filled lamps now used for street-lighting. There are two tiny coils of filament about one tenth of an inch in height and one thirty-second of an inch in diameter, connected by a loop at the top. The glass bulb is about two inches in diameter.

The light is about one hundred and seventy times more powerful than that given by the acetylene signal lamps now being used by the survey.



A specially constructed tungsten filament enables this lamp to throw its rays a distance of three hundred miles

Strange Mineral Spring Deposit in a Nevada Desert

ONE might study this desert photograph a long time before reaching the conclusion that it pictured the deposit of a mineral water spring, and a very small spring at that. The spring is situated on the southern border of South Carson Lake in western Nevada and is known as Allen's Springs. The flow of water is less than one-half gallon a minute, but in this very arid country even this meager supply is important as it represents the only drinkable water within a radius of over twenty miles.

The strange looking deposit is a yellowish porous mass of tufa, chiefly carbonate of lime, which has been left as the waters have evaporated in the desert sun. In addition to this tufa from the spring, there are thinner incrustations of similar material that were deposited from the waters of the now extinct Lake Lahonton which, in prehistoric times, was a lake of enormous dimensions. No definite conclusion can be reached as to the time in years that has elapsed since this lake reached its maximum area, except that geologically speaking the existence of the lake was recent—perhaps seventy-five or one hundred thousand years ago.

As the waters from a Nevada spring evaporated, a strange deposit was left. It is yellow, porous tufa

Orange Peel Oil Is Explosive

EVERYBODY knows the flavor of orange peel, but not everybody knows what causes that flavor. It is due to the oil contained in little cells in the rind. If the peel is bent so as to strain these oil-laden cells, the oil bursts out, often as a visible spray and usually perceptible to our sense of smell, and often as a greasy film on the fingers.

As shown in the accompanying photograph, the peel may be so bent as to rupture a large number of these cells at

A miniature explosion occurs when the oil from an orange peel is ignited

one time, and to fill the air with an oily mist. If, at the moment of bending, a lighted match be applied by an assistant a decided explosion will follow. This experiment is most successfully performed in a darkened room or in a room wholly dark except for the light from the match.

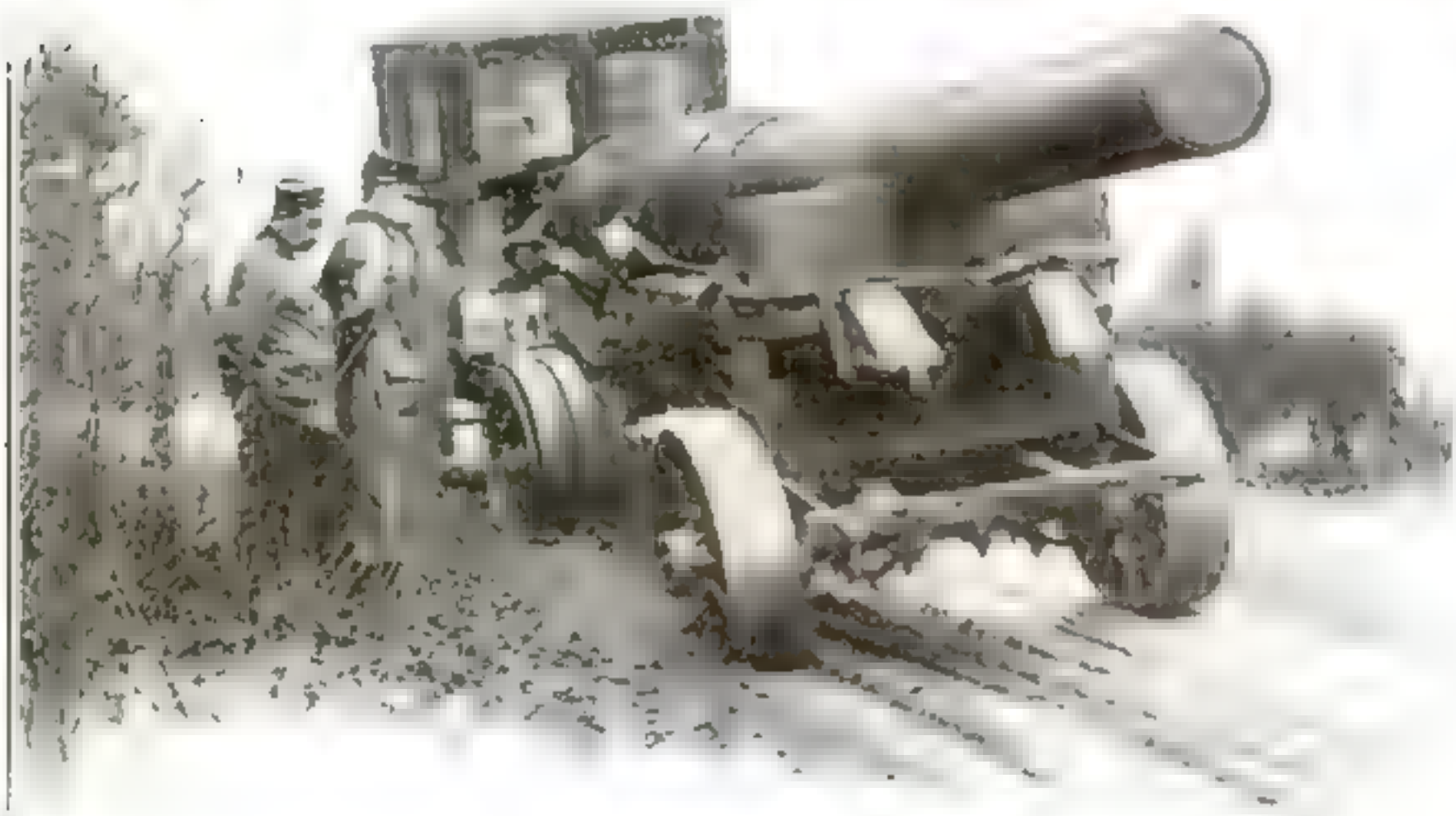
Air Raids Involve Problems Hard to Solve

LONDON'S problem of placing anti-aircraft guns is a serious one. The farther away from London they are stationed, the greater the number required to make the passage across the fortified zone sufficiently perilous. On the other hand, the nearer the guns are brought to the city, the more restricted is their action for fear of inflicting injury on those they are intended to defend. A possible solution to this problem is the employment of mobile guns.

The use of aircraft as a defense against air attacks has been officially stated to be inefficient by itself. The difficulties to be met are not regarded as insuperable, however, and great hopes are placed in future developments along that line.

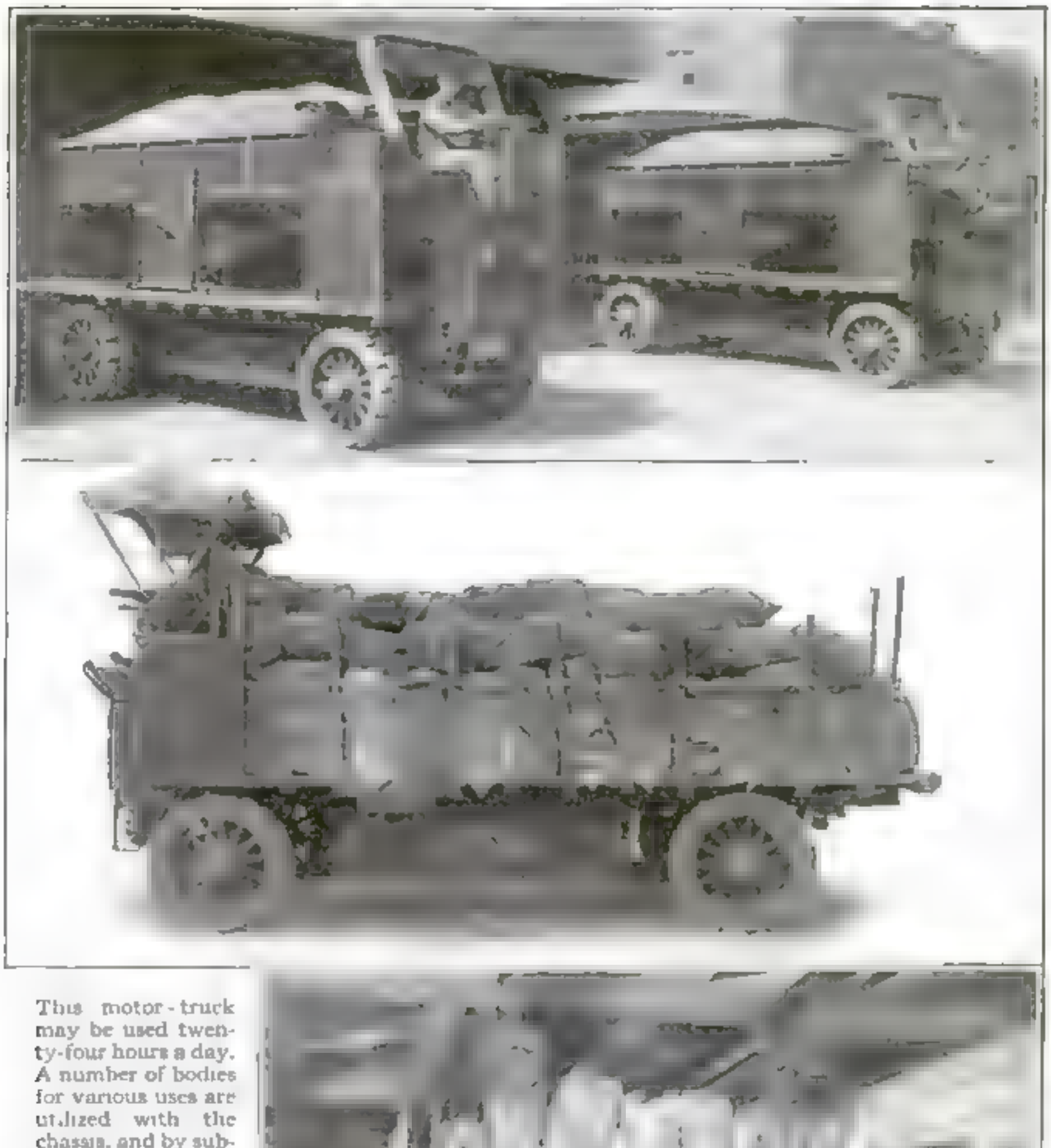
Truly a War of Motors

Besides displacing horses at the front in the World War, motor-trucks are also used to carry wounded chargers off the battlefield. Four ambulances like the one shown are now with the British Army in France. Each holds two horses. One side of the body swings down so that animals can walk or be hauled in. The twenty-ton naval gun below was carried by an American tractor over eleven miles of mountain roads which were badly torn up by shot and shell Despite these difficulties, the load was delivered



The great number of motor vehicles now in use in the war has necessitated the employment of vehicles whose sole purpose is to make quick repairs. The unit shown at the left is an American workshop with the Ninth Australian Corps. Note the complete equipment of forge, anvil, vise, drill presses and tools. Also note how the lower half of the body swings down to form a convenient working platform

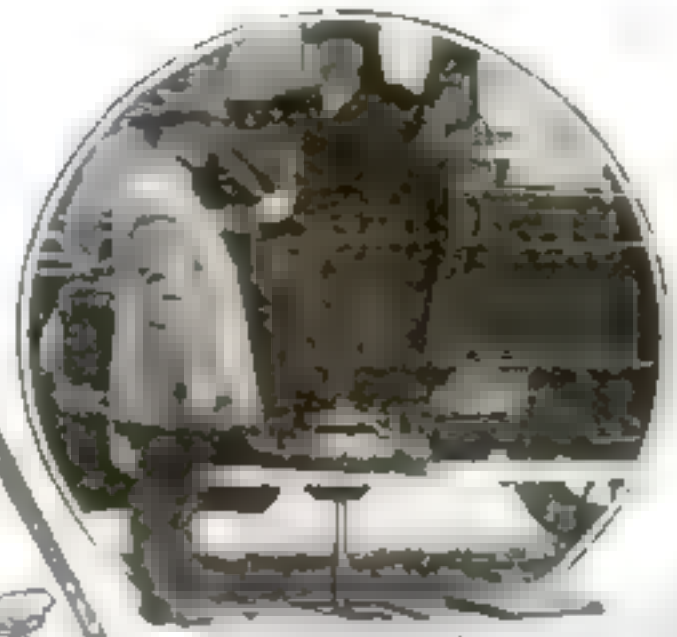
A Truck with a Long Day

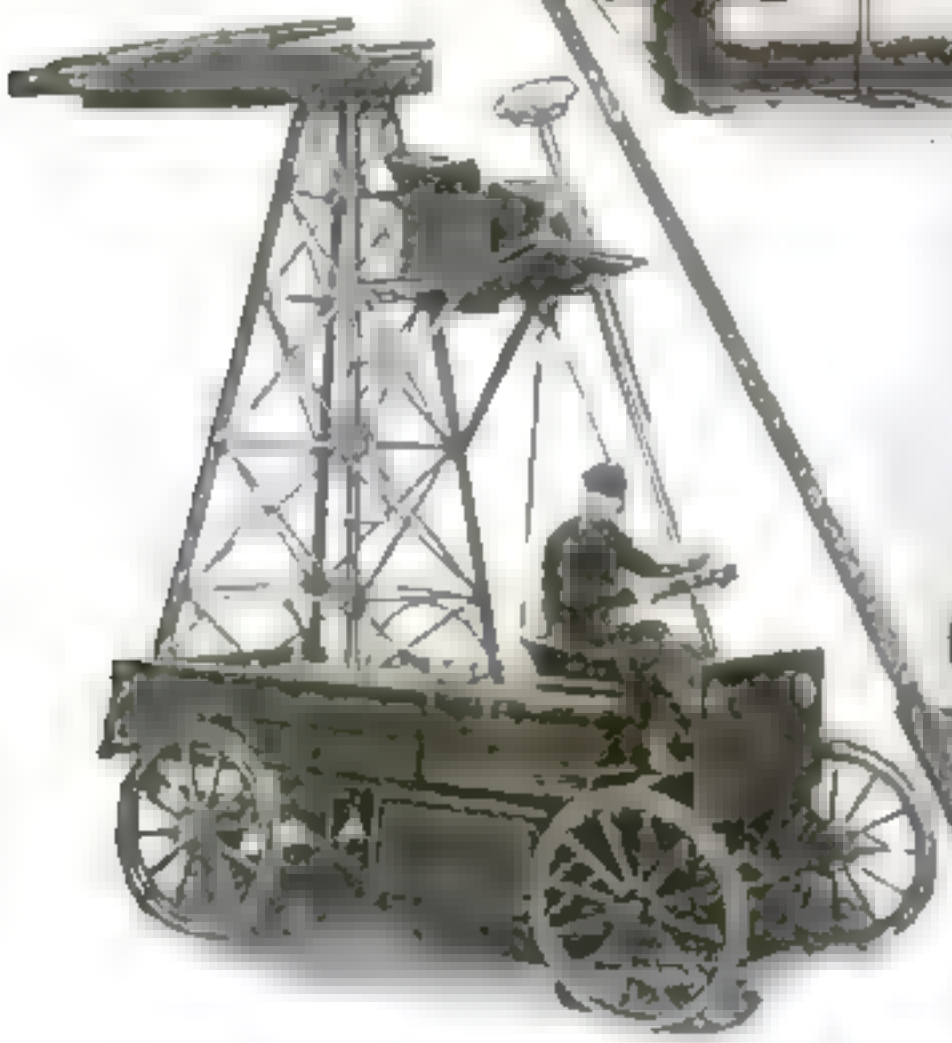


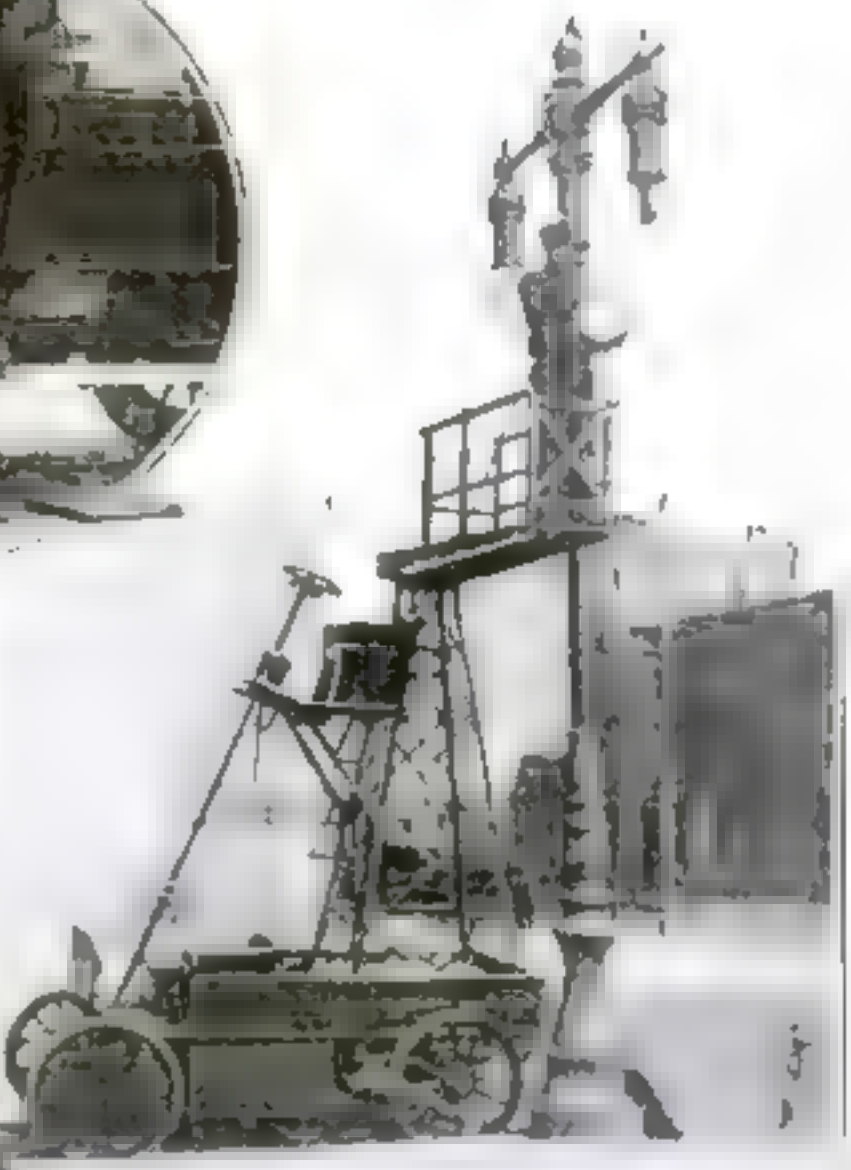
This motor-truck may be used twenty-four hours a day. A number of bodies for various uses are utilized with the chassis, and by substituting one for another the truck may be constantly at work. The bodies are loaded while the truck is busy, and when it arrives at the loading platform the bodies are exchanged by means of the overhead tackles shown in the lower illustration. Local transportation facilities have progressed rapidly since the motor-truck supplanted the horse

Consider These Miracles of Mechanics and Think

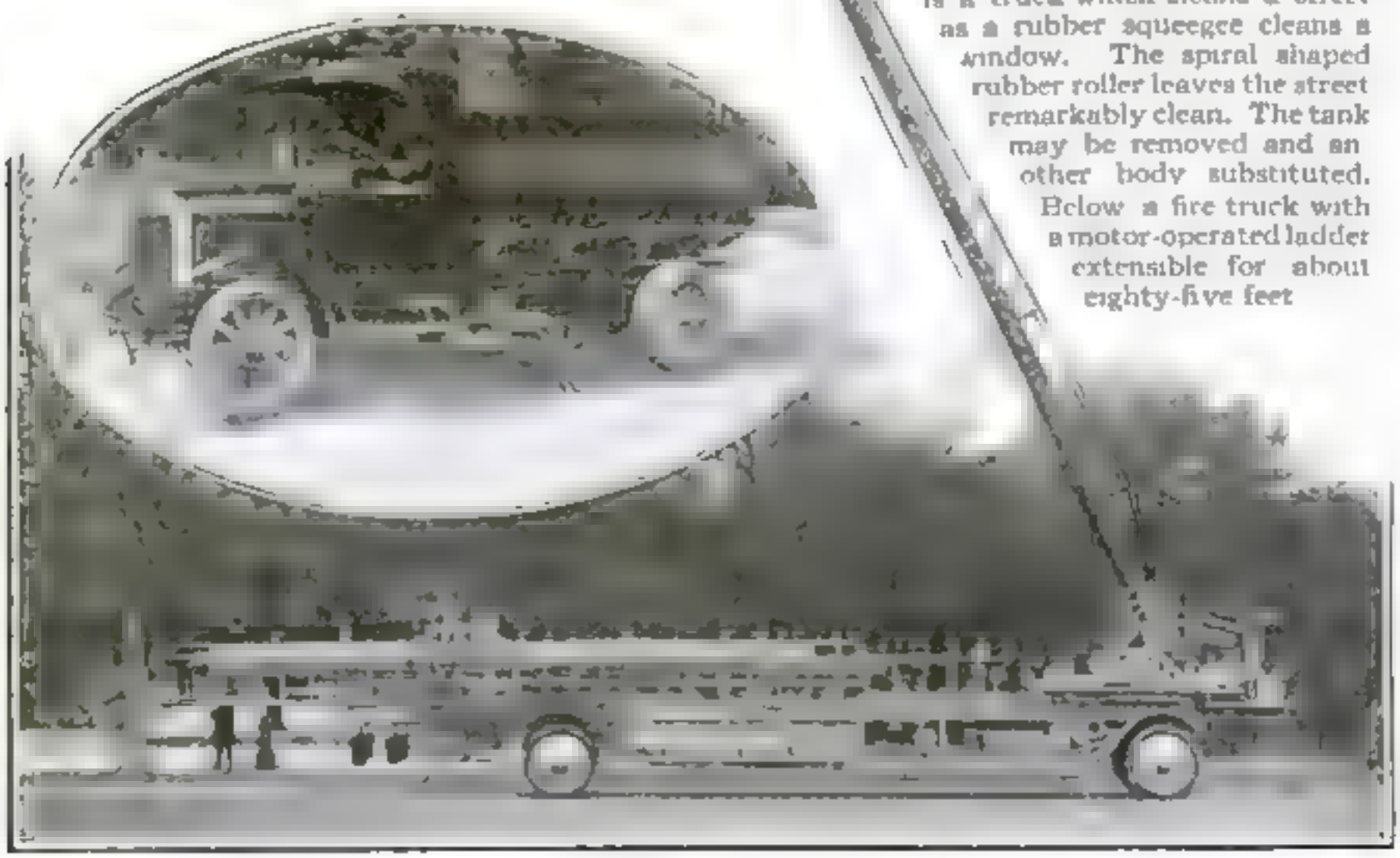
The device pictured on the right has robbed bursting water mains of their terror. The mechanically operated valve-closing apparatus is mounted on the running board. Below will be seen two pictures showing an electric truck used in Philadelphia for trimming arc lights







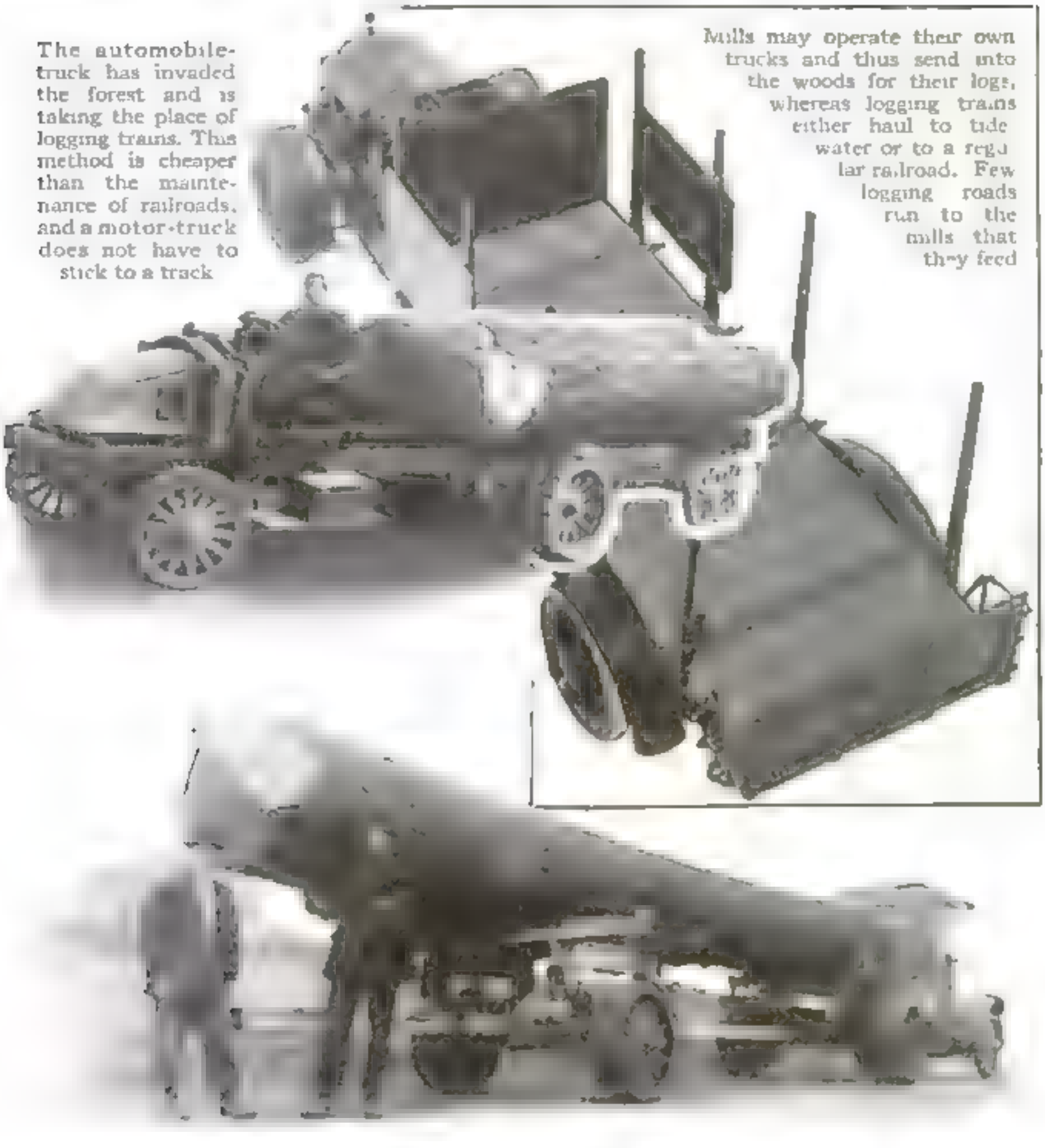
Above, a truck fitted with a steel tower and swinging extension platform. The driver may operate the truck either from the driving seat or from seat on the tower. Below on the left is a truck which cleans a street as a rubber squeegee cleans a window. The spiral shaped rubber roller leaves the street remarkably clean. The tank may be removed and another body substituted. Below a fire truck with a motor-operated ladder extensible for about eighty-five feet



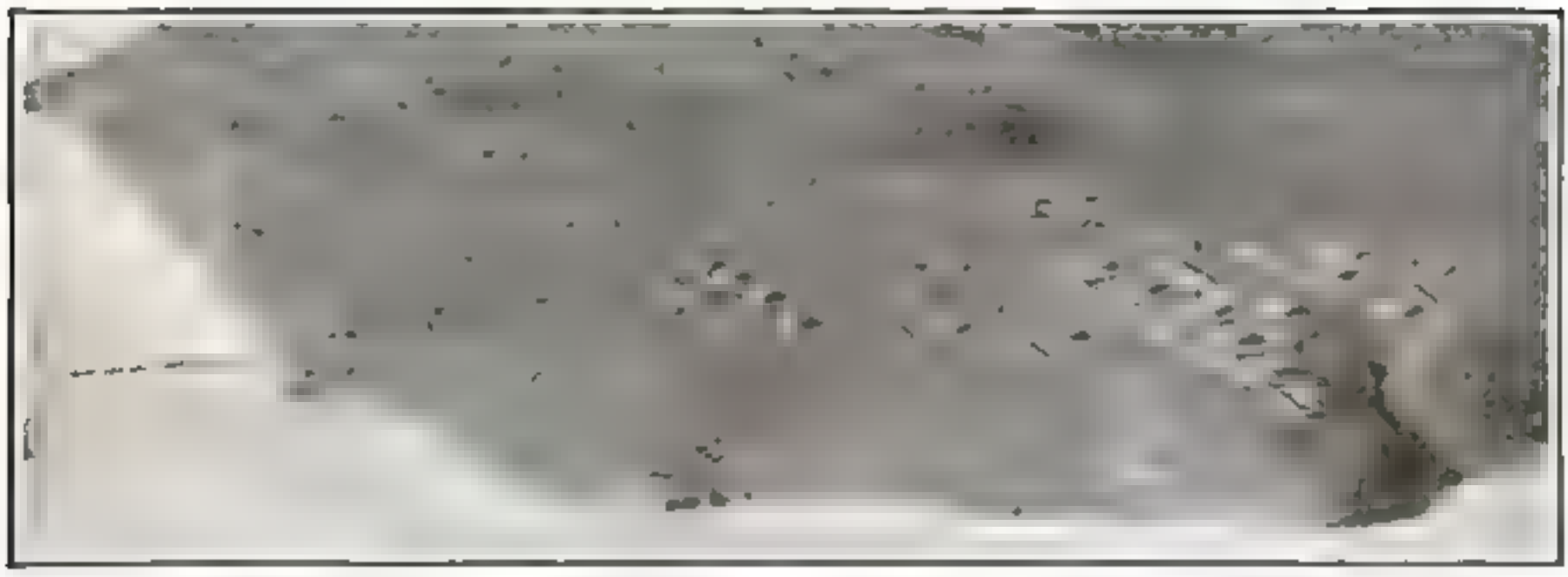
How Little We Accomplished With Horses

The automobile-truck has invaded the forest and is taking the place of logging trains. This method is cheaper than the maintenance of railroads, and a motor-truck does not have to stick to a track

Mills may operate their own trucks and thus send into the woods for their logs, whereas logging trains either haul to tide water or to a regular railroad. Few logging roads run to the mills that they feed



A crew of three or four men is required for a logging train, but a single man can handle a motor truck freighted with logs



In the National Museum at Washington is a model of the Island of Trinidad, showing the topographical details on a scale of one inch to sixty feet

A Model of Trinidad's Famous Asphalt Lake

THERE are several places in which natural asphalt in one form or another exists with but few impurities, the best known and largest being located on the Island of Trinidad, a British possession lying off the northeast coast of Venezuela. The island includes about one thousand seven hundred and fifty square miles of rather barren land. Near its center is a lake of natural asphalt about one hundred and thirty acres in extent, which furnishes over two hundred thousand tons of material each year. Nearly one half of this total is sent to the United States.

Nature seems to have endowed this remarkable lake with miraculous powers. The supply never decreases appreciably, in spite of the great number of tons of asphalt removed annually. From some eternal pitch-spring located far beneath the surface there continues to flow a steady stream of this fine road-building substance. Naturally it is not like water in consistency; it flows very slowly like cold molasses or tar. It is not unlike the asphalt seen in the carts in your own home town, but it is not boiling or even hot, except for the heat of the tropical sun which renders the work on the surface very uncomfortable. Since the lake is fairly solid, the men and teams go out on its surface to dig and haul the asphalt to the refining plant on shore. Although not molten, this lake has a perceptible motion, which prevents the construction of buildings for refining or a railway for transmission on its surface.

In the highest part of the model and near the center the black asphalt lake glistens. On the shore near at hand stands the refining plant, and the little tram-way which conveys the material ready for shipping down to the pier at the water's edge. Scattered about the island are many fine residences and rows of houses where dwell the working men and their families, as well as a club house built to accommodate the visitors, since the island has been converted into a very good winter health resort

---

An Improvised Flour Bin

IN the absence of a kitchen cabinet a convenient flour sifter can be made by using an ordinary bag and placing a sifter in the opening, after securely fastening it with heavy string. The bag is inverted and hung from a nail, conveniently placed above the work table by running a heavy string through the bottom. At first the flour will sift out as it shifts into position, but it will soon settle in the bowl of the sifter.

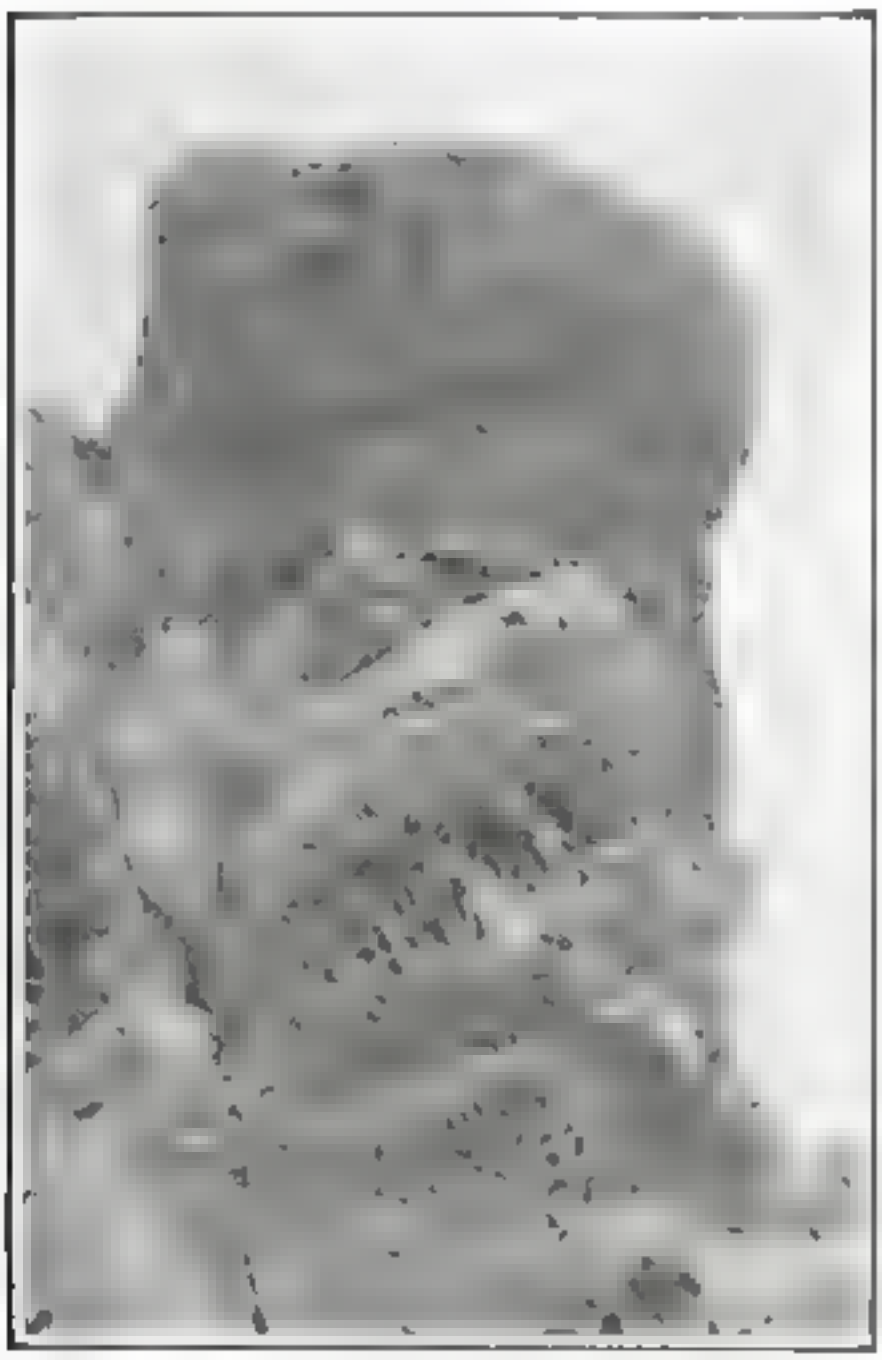
A flour sack is also a flour bin

A Strange Spongelike Rock

THE so-called sponge rocks near Livingston, Montana, have attracted the attention of many travelers and scientists on account of their remarkable tracery and porosity. They appear like huge pieces of pumice stone intricately carved by Nature into innumerable cells, webs and cavelets. Some of the pieces are almost threadlike.

The rock is sandstone, which was formed millions and millions of years ago when the entire State of Montana was the bottom of a sea. In the course of ages, Montana has been bodily uplifted several thousand feet.

The spongelike formation of the rock, as it appears to-day, is of course due to the wearing action of water and wind, the softer particles of the rock having been washed or blown away, leaving the harder portions standing. There are a number of these rocks in the same locality, and several of them are said to have been appropriated by wild bees and other insects.



The spongelike appearance of this rock is due to the wearing action of wind and rain

Take this portable dark-room with you in the woods and develop your negatives on the spot

A Portable Dark-Room for Photographers

A PORTABLE dark-cabinet has been invented, which does away with many inconveniences encountered by photographers in developing their negatives without the advantage of a suitable dark-room. A metal framework supports a table or shelf adjustable to any desired height. Extending above the table are two rods supporting a square frame to which is attached a large hood. This hood completely envelops the table and affords enough room for the upper portion of the photographer's body behind the table. A hole in one side of the covering is used for introducing the materials in the cabinet. Another hole in its lower part is provided with a strap or elastic band, which passes around the waist of the operator as he enters the hood.

The cabinet is lighted by a window of ruby glass directly over the table and opposite the photographer. Fresh air is supplied by means of a mask with a rubber tube leading to the outside. Tourists who take many pictures can make good use of this cabinet.

What Shall We Do for Gasoline?

THERE are about two and one-half million automobiles in use at the present time. By the end of the year their number will be well over three million. All of them consume gasoline. There are also three hundred thousand motor-boats, forty-five thousand motor-trucks, thirty thousand gasoline farm tractors, and an untold number of stationary engines, all dependent on gasoline. Over thirty-five million barrels of gasoline are annually required to meet the demands of these many motors.

The total gasoline content of all the oil produced in this country in 1915 is estimated at 1,892,500,000 gallons.

According to the preliminary report on the investigation of the rise in the price of gasoline, prepared by the Federal Trade Commission, the 1915 exports of gasoline amounted to fifteen per cent of the entire gasoline content of all the crude petroleum produced in the United States within the year 1915. Exports for the year of gasoline, naphtha, and benzene totaled eight hundred and twenty-four million, five hundred and fifty thousand gallons, as against two hundred and thirty-eight million, five hundred thousand in 1914.

We are burning up gasoline faster than we can distill it from the crude oil which we pump out of the earth. In past years so much gasoline was produced that some of it could be set aside for possible later emergencies. But even these stocks are now practically exhausted and we are living almost from hand to mouth

It has been suggested that benzol be used. Not until the war began did the United States of America make any serious attempt to recover benzol as a by-product of coke making.

Benzol is not greatly different from gasoline. Motorists object to it because it requires adjustments in the motor. Moreover, the quantity of it available will always be so limited as to preclude widespread distribution.

What is known as casing-head gasoline has been finding increasing favor. Casing-head gasoline is literally squeezed out of natural gas just as you squeeze water out of a sponge. The output of gasoline thus extracted is about one million and a half barrels a year.

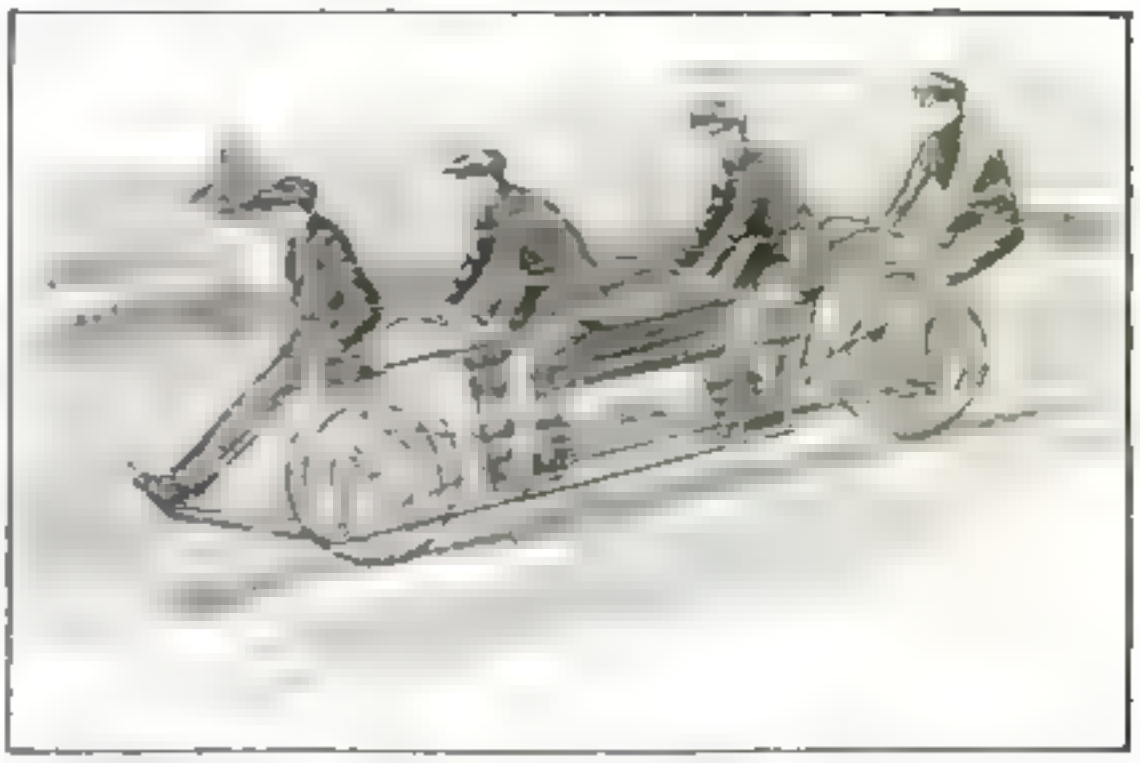
In the ordinary method of distilling petroleum, heat is applied. At low temperatures the vapors of the lighter constituents of the oil are distilled off and condensed. As the temperatures increase the heavier vapors rise; finally a heavy mass is left from which no fuel at all can be distilled. The line of demarcation between gasoline and kerosene is ill-defined. Hence in the days when the kerosene lamp was in vogue and when gasoline could not be sold for lack of automobiles, the oil refiner retained as much gasoline in his kerosene as he dared. Nowadays the situation is reversed. Gasoline contains as much of the kerosene element as possible. From year to year, gasoline is becoming heavier and heavier. But even this device of the refiner, made necessary by the enormous demand for motor fuel, has failed to meet the situation. So, for years oil chemists have been trying to devise plans whereby kerosene itself could be subjected to further heat treatment—a heat treatment which is known as "cracking," and which serves to break up the kerosene molecules into gasoline molecules. One of the most successful of these processes is that invented by Dr. Burton. Thanks to him at least three hundred thousand automobiles are now running on cracked gasoline. More recently Dr. Rittman has come to the public notice as the inventor of a cracking process for which marvelous things are claimed. Dr. Rittman believes that the cracking process will solve the gasoline problem.

A cheap motor fuel is a vital necessity to the automobile industry. The cheapest at present available is kerosene. But unlike gasoline it demands a special type of carbureter—an apparatus which will perform its function far more scientifically and accurately than is necessary with gasoline. If present indications mean anything at all they mean that motor car manufacturers will develop a type of carbureter which can be successfully used with kerosene.

Freak Motorcycle Carries Four Passengers

THE oddest thing yet constructed in the motorcycle line is a freak mount designed to transport four passengers, with the foremost man sitting on a spring bucket seat and the other three directly behind him on regular motorcycle saddles. The frame of the machine is a double trapezoid. It has the front and rear wheels sprung somewhat on the lines of spring forks, with a shock spring above and a recoil spring below. The wheelbase is sixty-six inches.

The motor, which uses kerosene as a propelling fluid, has two cylinders and is water-cooled. Each cylinder has two pistons. There are two crankshafts coupled by means of a longitudinal rod having worm gears. This rod drives the camshaft, magneto and water pump. The final drive is by V-belt to the front wheel. Four-inch tires are used, and band-brakes are fitted to both wheels.



This four-passenger motorcycle is under the control of the man in the rear

Combined Eye-Shade and Program

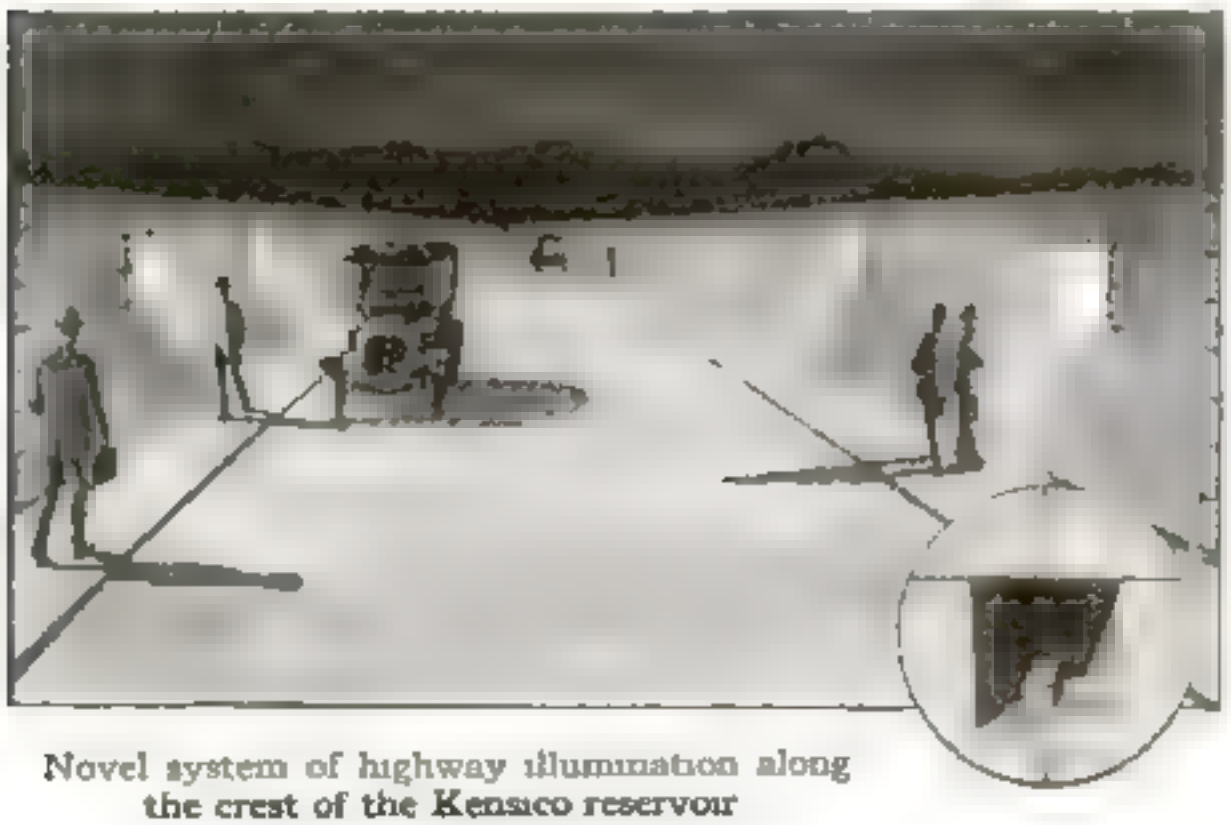
A COMBINED eye-shade and detachable program or printed matter section can be affixed to a hat by a simple curved clip device having a shank at one end to engage a loop on the eye-shade, and at its other or free end, extending below the attaching shank to press on and grip a hat brim firmly. The eye-shade passes under a hat brim and the clasp holds it firmly in place with all types of hats.

Program and eye-shade combined

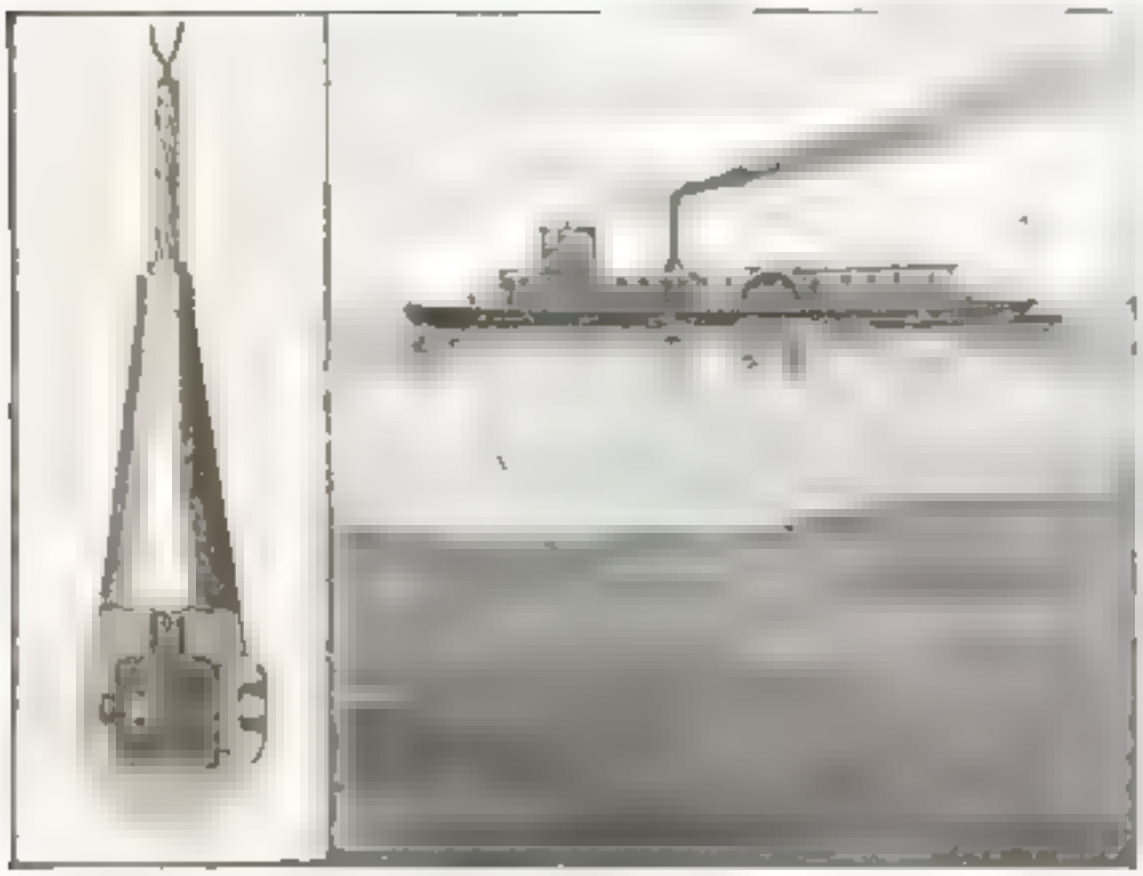
Illuminating a Highway With Pockets of Light

UNTIL Wilson Fitch Smith, division engineer of the Catskill aqueduct system of water supply of New York city, worked out an illuminating plan of his own by using lanterns and boxes, nearly two thousand feet of the State highway which is laid out on the dam across The Bronx valley, was unlighted.

Mr. Smith did not want to erect unsightly poles on top of the dam for illuminating the highway at night, and as there was no other method available, he hit upon the novel idea of lanterns and boxes. Subsequently cubical pockets were cut in the heavy stone slabs and the proper connections made. The lantern-box combination gives a remarkable uniformity of light, and the artistic effect is pleasing.



Novel system of highway illumination along the crest of the Kensico reservoir



A simple telephone transmitter dragged through the water reveals the nature of the river-bed

Navigating a River Boat by Sound

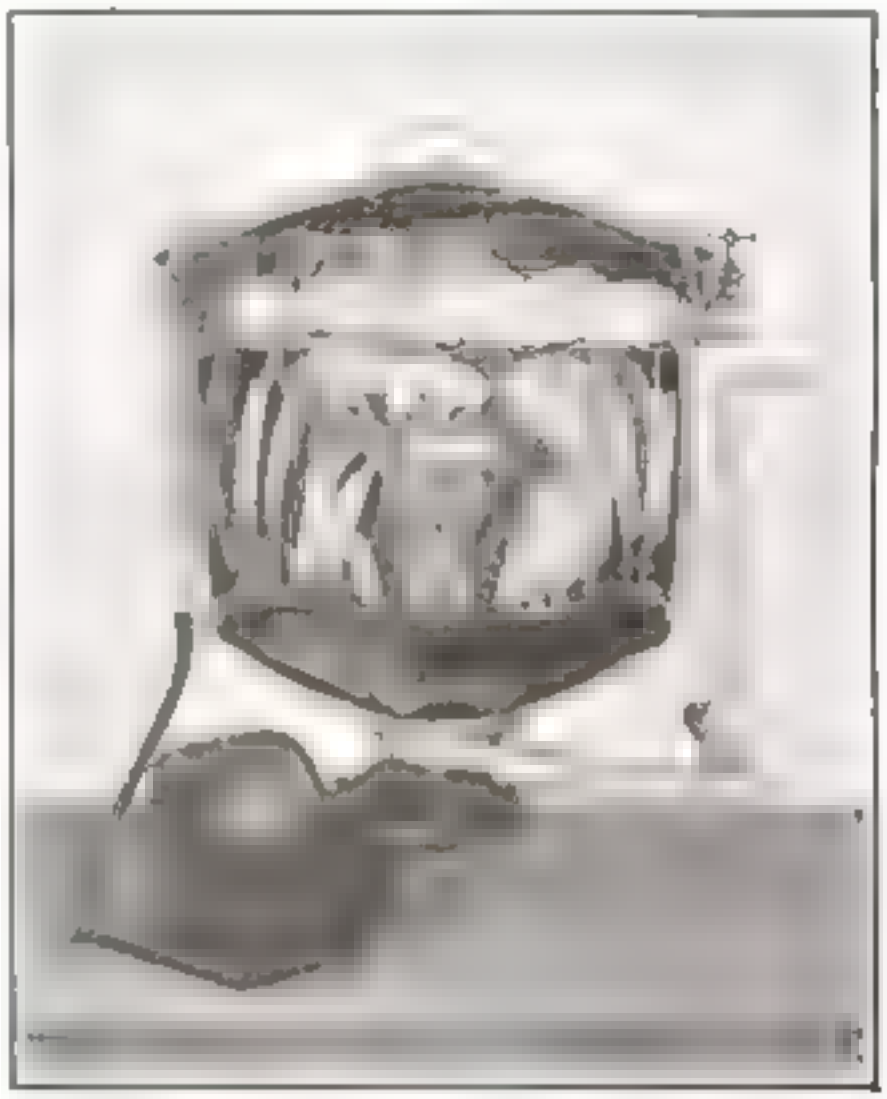
TO determine the character of inland river beds, steamboat captains are using microphones installed in sounding leads. On each ship an armored cable leads from the microphone to a telephone receiver and dry batteries. When the sounding-lead drags over the mud bottom, a dull groaning sound emanates from the receivers, while a stony or pebbly bottom will cause a series of sharp, staccato raps.

Doing Away With the Dish-Cloth

A DISHWASHER has been perfected which does its work quickly and well and which eliminates the unsanitary dish-cloth. The machine consists of a cylindrical container with a diameter of about two feet, funnel-shaped at the bottom and having a tightly-fitting cover to prevent the escape of steam. A wire tray with grooves holds the plates in an upright position, and a central basket contains knives, forks and spoons. After being filled, the tray is placed in the bottom of the container. Above it is another tray for the teacups, water-glasses and smaller dishes. Below both trays, in the funnel-shaped bottom is a triangular arm, or fan, which rotates at a high speed, throwing the water upward against the dishes.

After placing the trays with their dishes in the machine, hot water is poured in, the cover adjusted, and the lever operated for two minutes. The soiled water is then drained off, fresh boiling water applied, and the operation repeated. The dishes are thus washed and sterilized. They dry of their own accord if the water is hot enough. Of course it is well to scrape the dishes reasonably clean before putting them in the container.

The convenience of the machine may be increased by a water-pipe connection and a drainage pipe. Also a small motor eliminates the use of the hand-lever in operating the machine.



Washing and drying the dinner dishes without a cloth and towel

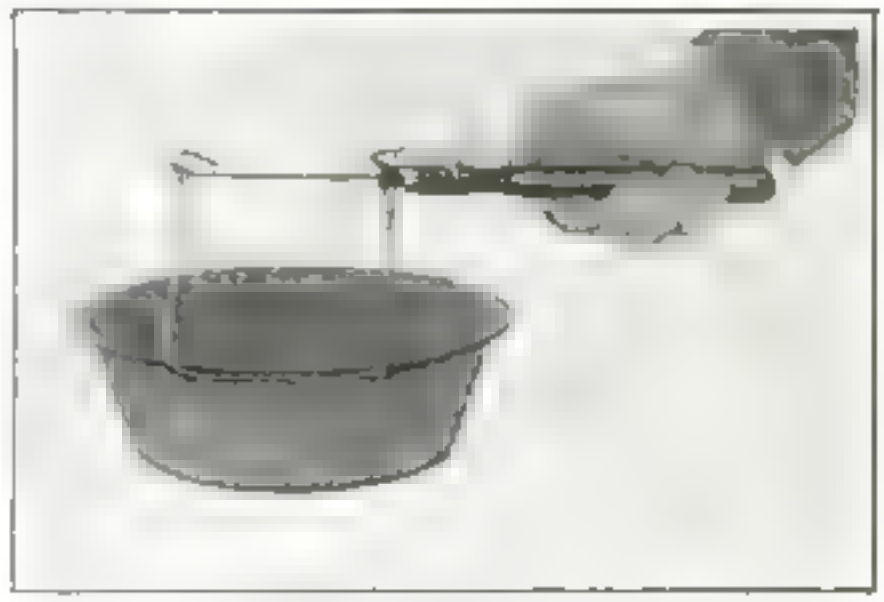
---

If you want further information about the subjects which are taken up in the Popular Science Monthly, write to our Readers' Service Department. We will gladly furnish, free of charge, names of manufacturers of devices described and illustrated.

Bird Protection for Electric Lines

SOCIETIES for the protection of birds have insisted with particular emphasis that central station managers should provide suitable safeguards to prevent the electrocution of birds which perch on high-tension lines. These endeavors have generally been welcomed by the power companies, not because they pity the birds, but because short-circuits might be produced and great damage caused. The arcs produced through the body of a bird, between the line and grounded iron parts, are a serious menace for electric plants. Fluctuation in voltage is caused and worse still may happen if two birds should produce short-circuits. For this reason the system illustrated in the accompanying figures was evolved by one of the large German electric companies.

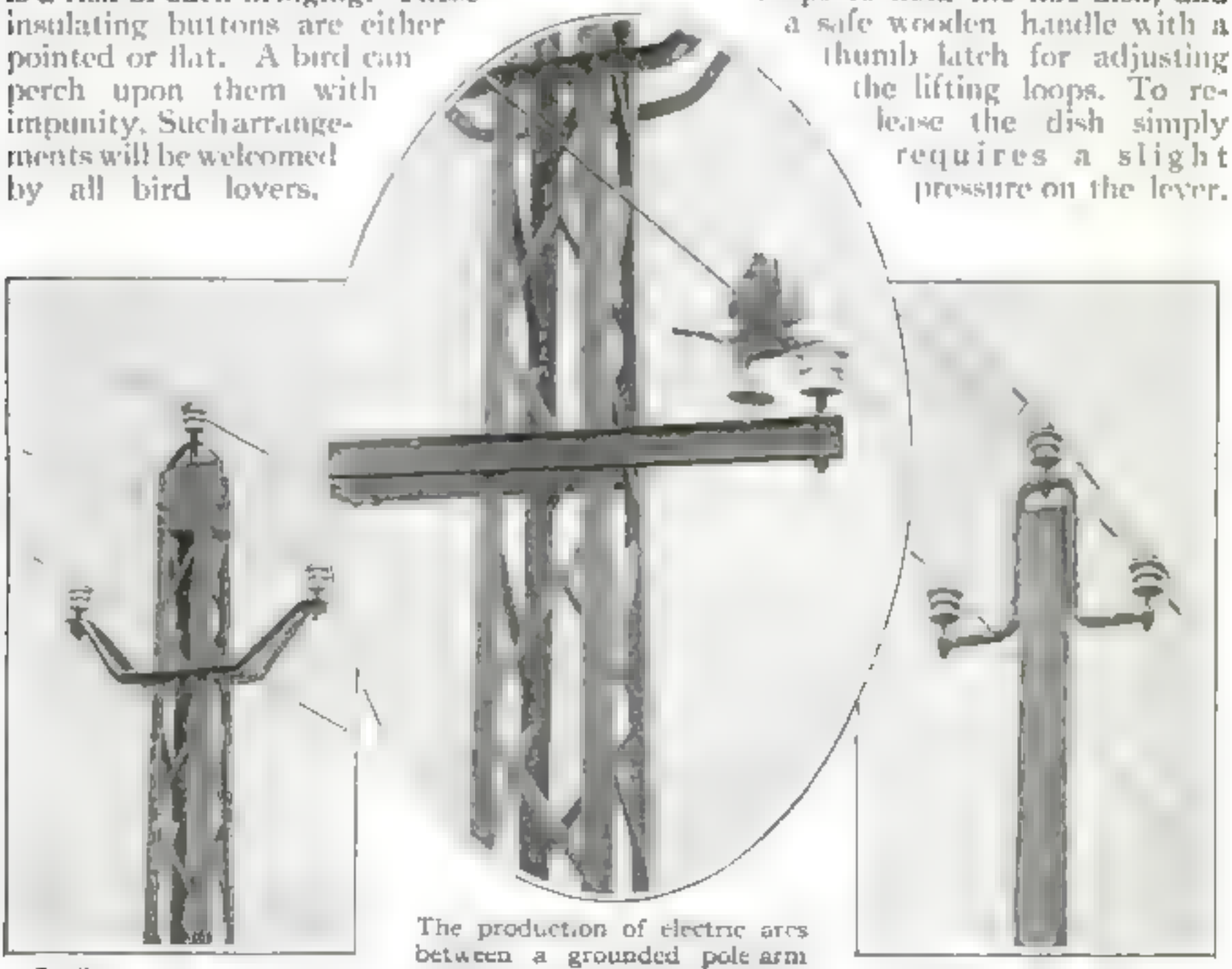
In order to prevent the production of electric arcs between a grounded pole-arm and live conductors, an insulating button is fixed wherever there is a risk of such bridging. These insulating buttons are either pointed or flat. A bird can perch upon them with impunity. Such arrangements will be welcomed by all bird lovers.



A convenient lifter for hot dishes

It Saves the Cook's Hands

NO modern cook need make a burnt offering of her fingers on baking day, for it is no longer necessary to draw hot, handleless pie-pans and pudding-bowls from the oven with hands poorly protected by dish towel or apron. For a few cents she can buy a simple mechanical lifter which solves the difficulty. This consists of wire loops to hold the hot dish, and a safe wooden handle with a thumb latch for adjusting the lifting loops. To release the dish simply requires a slight pressure on the lever.



Inclined arms are an effectual safeguard

The production of electric arcs between a grounded pole arm and a live conductor is avoided by means of an insulating button

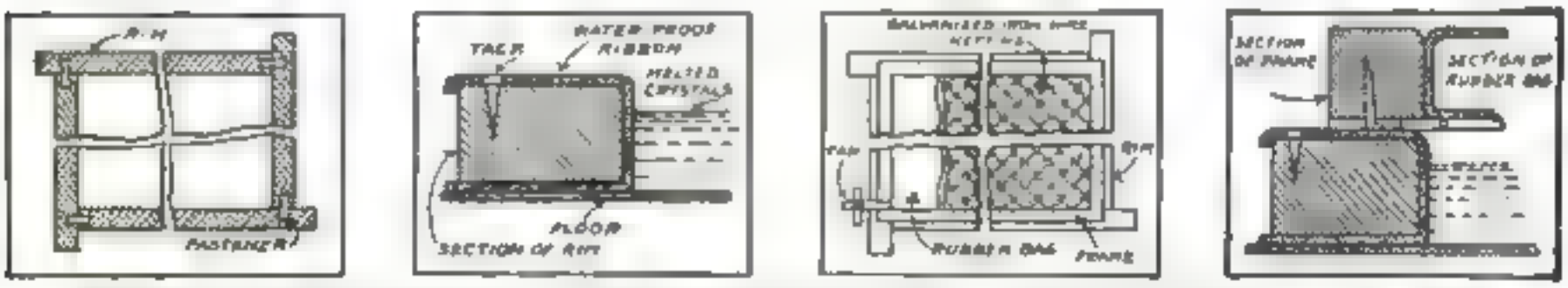
Wooden poles only require insulating supports

Ice Skating in Summer Without Ice

ICE can be made artificially for summer skating. It has the disadvantage of melting. For that reason, chemists have devised glassy surfaces which will stand heat and which will be as acceptable as ice in winter.

Some years ago a German patented a process, in which thick pasteboard plates are immersed in very hot linseed oil and varnish, mixed with glue. After becoming thoroughly permeated with this mixture, they are subjected to a powerful pressure, which squeezes out the excess of oil and gives them great strength. When dry, the plates are immersed in hot paraffin and again put under pressure. To one side of each plate a layer of parchment is applied; the other side is coated with gypsum and tar. The plates, with the parchment sides up, are then fitted together on the floor and united by cement. The finished surface of the rink is coated with a material consisting of one part of glycerin, two parts of wax, and three parts of oil. An unusually smooth floor is thus formed; but ordinary skates cannot be used, since their sharp edges would soon cut up the surface beyond repair.

Another compound contains soluble glass, fluor-calcium, asbestos, ground glass or flint, paraffin and soapstone. These substances, when thoroughly mixed, are applied to the floor. A thin coating of soluble glass and a layer of paraffin are then added. Absolute smoothness is obtained by passing a heated roller over the surface. If the surface becomes scratched, more heat is applied, or fresh coats of glass and paraffin are added.



Diagrams showing treatment of floors. The hot salts are poured into frames on the floor After solidifying, the frame is removed and used for the next section. The frame with the galvanized iron wire nets is used in re-surfacing the floor, a rubber bag filled with steam being laid on it. The heat is thus applied without bringing the bag into direct contact with the salts

Skating on Salt

The idea of using crystalline salts, such as the carbonates and sulphates of sodium, potassium and other substances having like properties, has also been suggested. The salts are boiled and then poured directly on a water-tight floor, having raised edges. The floor should be laid in sections, by means of a frame for holding the melted salts. After they solidify, the frame can be used for an adjacent section.

This same method has been improved so that a good permanent sliding-surface is obtained. When the rink becomes badly scratched, due to excessive use, heat is applied by means of a rectangular frame supporting a wire lattice-work. The frame is placed on the floor and a rubber bag, filled with steam, is laid on the lattice-work. The action of the heat melts the salts, so that a flat, smooth surface is formed.

The porous substance permits the surplus moisture to pass from the magnesium chlorid to the crystalline top layer or vice versa

Another device for heating resembles an ordinary garden rake. Steam is blown on the floor through a longitudinal slit in a tube. The tube has a handle and two runners for guiding it across the floor. The pipe for supplying the steam passes down the handle and connects with the lower horizontal tube.

This smoothing process is too frequently necessary, owing to the varying degrees of humidity in the atmosphere. To do away with this difficulty, at least partially, one inventor places a thick sheet of sodium carbonate upon a layer of porous material, which, in turn, rests upon a floor having many intersecting channels. Water, circulated through these channels, is absorbed by the porous material and thus comes into contact with the top layer. This tends to prevent the air from affecting the sodium carbonate, but does not completely overcome the difficulty.

The nearest approach to perfection is a combination of substances now being used in Germany with success. Below the porous layer is a sheet of some hygroscopic (water-attracting) substance such as magnesium chlorid. When the air is humid, the excessive moisture from the crystalline top layer passes into the middle porous layer, and then into the bottom layer; when the air is dry, moisture reaches

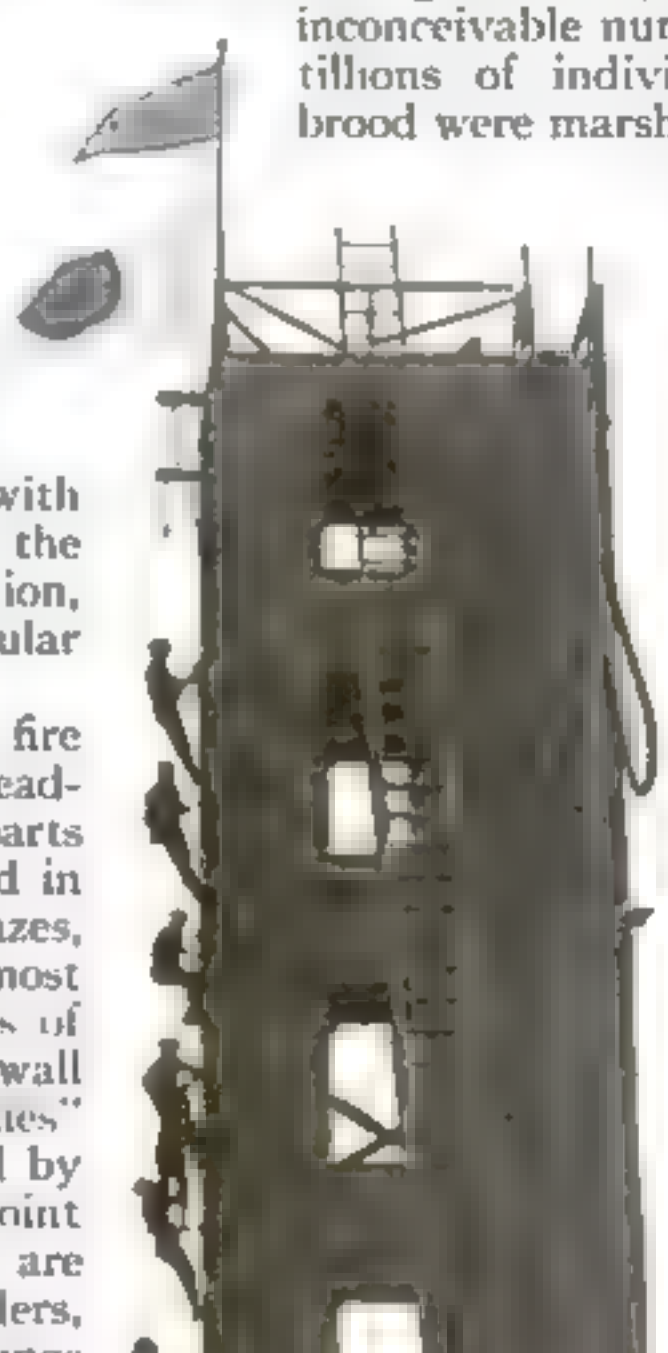
Intersecting channels underneath the salts are filled with water to be taken up by the porous layer

the salts on top by passing up through the porous substance from the magnesium chlorid below. In this way a good sliding surface is maintained.

Limbering the Muscles of Fire-Fighters

THAT the fireman's life is not all velvet was proved in New Orleans recently, when the fire department turned out in force and did some remarkable feats of quick ladder-climbing for the edification of the public. A tall wooden tower was erected, ladders were hoisted into position, and up these the firemen climbed in record-breaking time. The fire chief was so pleased with the demonstration that he ordered the tower to remain in its original position, to be used in the future for regular ladder-climbing exercise.

In New York, where there is a fire college connected with Central Headquarters to which firemen from all parts of the world come to be enlightened in the latest methods of combating blazes, ladder-climbing forms one of the most rigid courses of training. All sizes of ladders are put up against the rear wall of the college and up these the "rookies" or probationary firemen are ordered by their superiors At the topmost point of the highest ladder the rookies are sometimes sent with scaling ladders, which they attach to stone outcroppings or window sills and go up fifty or sixty feet further. This is the kind of training which instills a spirit of daring in the men. The training is made to resemble, as closely as possible, the problems involved in the actual work of fire-fighting.

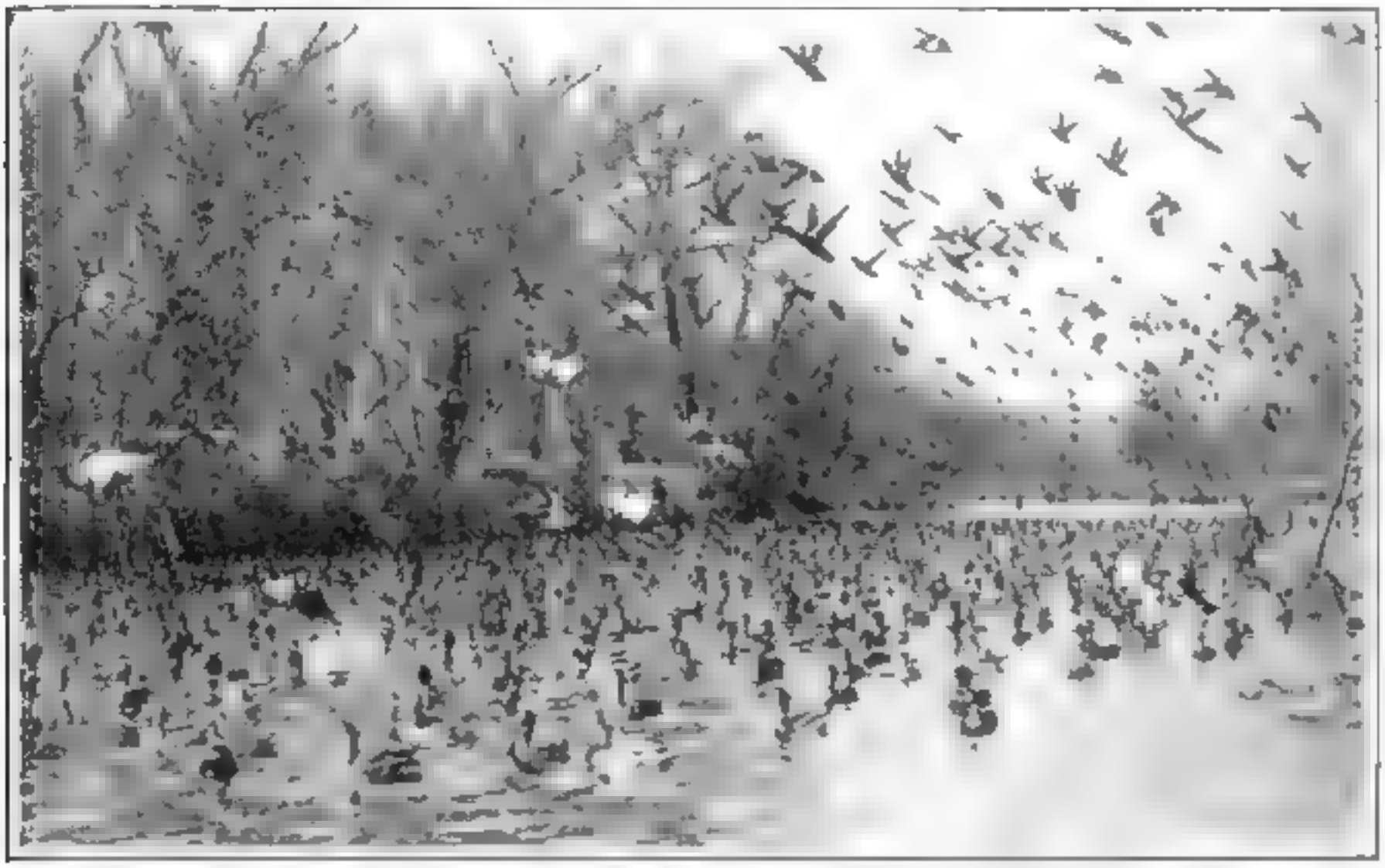


A demonstration of firemen's ability in ladder climbing in New Orleans, La. These men proved so efficient in practical life-saving methods, that their chief ordered the tower to be left in position for the drilling of recruits

One Reason for Appreciating the Value of Birds

THE fecundity of certain insect forms is astounding. The progeny of one little insect, the "hopaphis," sees thirteen generations born to it in a single year, and would, if unchecked to the end of the twelfth generation, multiply to the inconceivable number of ten sextillions of individuals. If this brood were marshaled in line, ten to the inch, it would extend to a point so sunk in the profundity of space that light from the head of the procession, traveling at the rate of one hundred and eighty-four thousand miles a second, would take two thousand five hundred years to reach the earth.

In eight years the progeny of one pair of gypsy moths could destroy all the foliage in the United States, if unchecked.



Thousands of ducks find a safe shelter and breeding place at the United States Game Preserve at Wichita, Idaho

Game Preserve for Ducks

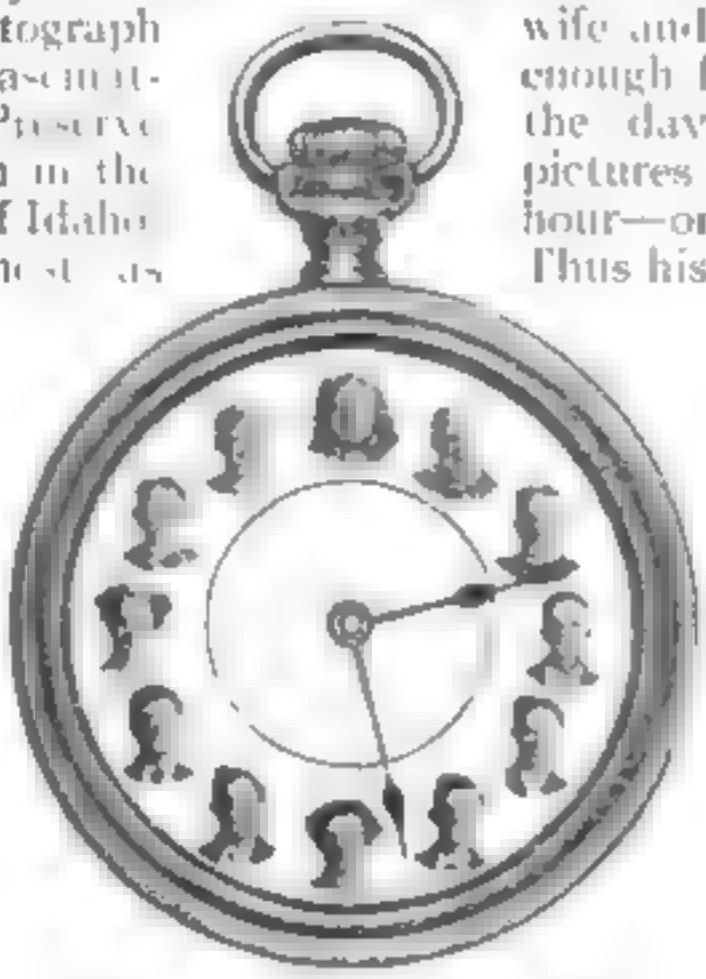
TO protect the wild ducks and other birds, besides having a general closed hunting season, a number of game reserves have been established both in the United States and Canada. Wild fowl soon learn the safety of such resorts and enormous flocks may be seen in these havens. The photograph shows an exceptionally fascinating view in the Game Preserve established by Uncle Sam in the Wichita National Forest of Idaho. These same ducks, almost as friendly in the Game Preserve as tame ducks, allowing themselves to be photographed at very close range, will be as wild and wary as hawks as soon as they have left its protecting borders and scattered among adjoining lakes and rivers.

What Time Is It? Half-Past Aunt Sarah by This Watch

IF you happen to ask C. W. Humberd of St. Joseph, Missouri, what time it is by his watch and chain he is apt to reply: "Just about half-past Edith" or "a quarter to Calvin" or "fifteen seconds after Albert." And then, of course, you are shown the watch and the mystery begins to unravel itself.

Humberd, who is a contractor, has a wife and ten children, just a big enough family for every hour in the day. Humberd had their pictures arranged—one for each hour—on the dial of his watch. Thus his watch has thirteen faces—twelve of them smiling.

Humberd himself starts off as one o'clock. Then comes Mrs. Humberd an hour behind him. The eldest son is three o'clock, followed by two other sons, so that it is six o'clock before the first daughter appears. At nine o'clock there is another daughter, and so on down through the whole happy family of children.



It is nearly half past Aunt Sarah by this curious watch

Are Metals Alive?

CHANGES in hardness, strength or elasticity in certain metals may be due to conditions analogous to disease in organic tissues, according to some metallurgists. This theory of the disease of metals has been so far accepted in Germany that the Imperial Navy Yard at Wilhelmshafen sends metals regularly to "the autopsy room and dissecting tables" of Professor Heyn, a leader in this kind of work. This new conception of metals is due to the studies made some years ago by Professor Jagadis Chunder Bose, an East Indian physicist of Presidency College, Calcutta, who proved experimentally that it is scientifically wrong to divide matter into "living" and "dead." He demonstrated that the phenomena which we commonly associate with life should also be associated with non-living metals, books, paper and the like.

It seems as if metallurgy will create a new and vastly important branch for itself—the branch of producing inoculating material for metals, which shall change their temper and form swiftly instead of waiting for the slow processes of forging and tempering that obtain to-day.

Heyn has been studying the modifications in iron under all grades of temperature, and he holds that the metal passes through various stages of disease that produce structural changes just as the cells of plants and animals change in form, size and position. He heats copper in order to find why that metal suffers from over-heating, and he concludes that it becomes poisoned with copper protoxid, which so sickens it that its structure changes and partially breaks down

The metallurgists have joined the chemists in erasing the line which divides all substances into organic and inorganic —just as the line between animal and plant life has ceased to exist. The German metallurgists have come to speak as a matter of course of the life that unfolds itself in steel under various temperatures that are applied to it in working it. Poison steel with hydrogen or hydrogenous matter and you so sicken it that it gets into a condition where it is as brittle as if it had been ruined in tempering

Pure glycerin cannot be frozen by ordinary means, even at twenty degrees below zero. But, introduce a bit of glycerin that has already been frozen and the rest begins to congeal. This process is nothing more nor less than inoculating an inorganic substance with crystals in order to breed in it the condition of crystallization.

Bredig, a German investigator, found the point of infection in the crumbling tin roof of the Council House at Rothenburg. The roof suffered from a disease, now known as tin pest.

Answers to Sam Loyd's April Puzzles

Answer to "Off His Beat"

The mathematical cop says that his conversation with the Roundsman occured at 9:36 A. M., because 1 4 of the time from midnight would be 2 hours and 24 minutes, which added to 1/2 the time until midnight, 7 hours and 12 minutes, equals 9 hours and 36 minutes. Had the Roundsman not remarked it was morning, 7 12 P. M. would have been an equally correct answer

Solution of "At the Auto Races"

The race of the three autos might have terminated in 26 varied results, as follows

Assuming that all three finished six ways, viz: A, B, C; A, C, B; B, A, C, B, C, A; C, A, B; C, B, A. Then A, B, C in a dead heat or A, B; A, C or B, C in a dead heat for the first place. Then again, A first with B, C, in a dead heat for second or B first with A, C, second or C first with A, B, second. Then there are various results in which one or more of the cars fail to finish All three might fail to finish Then there are nine different results in which one car failed and with two failing to finish there are three ways.

Answer to "Cheese and Crackers"

Let us call the weight of the cheese X, and the balance board would be 1, 2 X. Four-fifths of the board, and therefore, 4 5 of its weight would be on one side of the balance point Let us assume that the beam was 5 feet in length. Then on the cracker side, at the point 2 feet from the fulcrum (the average distance), would be a weight pressure of 2 5 X pounds. This being equivalent to a 1 5 X pounds pressure at the extreme end. On the cheese end of the beam would be a pressure of 1 1 20 X pounds. This to balance would require a pressure of 21 80 X pounds at the end of the long arm. Since a pressure of 16 80 X already existed, the difference to be made up in crackers would be 5 80 X.

Therefore, the ratio of crackers to cheese would be as 5 to 80.

Answer to "At the Stamp Window"

The cashier gave the postal clerk a $1,000 bill in exchange for 18,816 one-cent stamps, 14,112 two-cent stamps, 10,584 five-cent stamps and 5 eight-cent stamps. No other United States bank-note can be divided in the manner necessitated by the cashier's order

Answer to "Juggling the Digits"

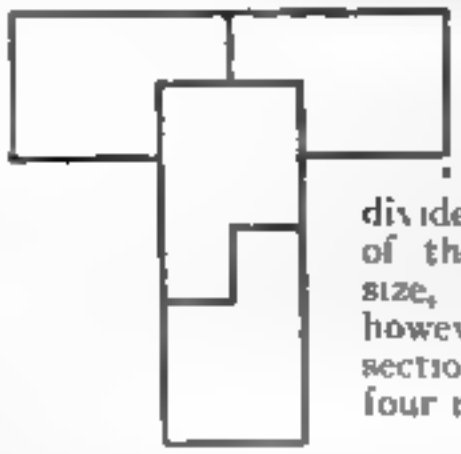
Solution of the schoolmistress' puzzle of the digits involves the interesting principle of "residual roots," which means the continuous addition of a group of figures until a single figure results. For example, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, added together equal 45. Four and five equal 9. No matter how those figures may be grouped in a sum, without employing fractions, the "root" number will always be 9. The root of 1916 is 8, so it is apparent that the given problem cannot be worked out without resorting to some method which will reconcile the discrepancy in roots. Following are three methods wherein fractions are employed to bring the result

1907	56	1907	68	1907	86
3	—	2	—	2	—
4	28	5	34	5	43
1916		1916		1916	

Answer to "How Old Was Jimmie"

On school registration day Jimmie was 9 3/5 years of age; his mother was 38 2/5 years; his father 50 2/5 years and his sister 16 4/5 years.

Answer to "Dividing the Farm"



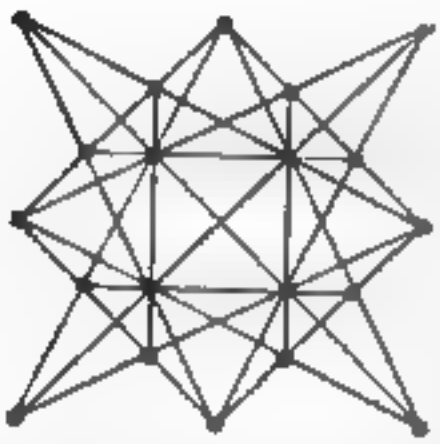
The accompanying diagram shows how the land formed like the letter T is divided into four pieces of the same shape and size, it being necessary however to turn over one section in order that all four may be exactly alike.

Answer to "On the African Firing Line"

There are 8 cocoanuts in evidence in the picture, which may be accounted for as follows: The Zulu threw the first and the monkey the second and third. Then the Zulu picked up one and threw it back. The one he threw came back with two more from the monkey, which would account for five upon the ground. Again he picked up one and threw it, bringing two more, which would account for 7 on the ground. Once more he picked up one and threw it as his parting shot. It came back, making seven on the ground as shown in the picture. According to schedule, the monkey was entitled to two shots, and in the picture we see his first, which scored a bull's eye.

The Zulu threw 4 cocoanuts.

Answers to May Puzzles



Answer to "Play Ball"

The diagram shows how 18 rows, 4 balls in line, may be scored in an arrangement of 20 balls.

Answer to "How Large Is This Man's Lot?"

The lot must have been 150 feet wide by 150 feet deep, having an area of 22,500 square feet. He had 190 poles, and if he had placed them two feet apart around the lot, he would have been 110 poles shy, whereas, if he had planted them two yards apart he would have had 90 poles left over.

Answer to "Children A-plenty"

Miss Pocahontas Smith must have been 24 and little Captain John 3, with 13 brothers and sisters ranging between. "Seven times older" is equivalent to "eight times as old."

Answer to "A Daisy Game"

The correct reply to play of 1 and 2 is to take 8. This divides the daisy into two parts of 5 petals each. You may then imitate every play of your opponent. Should he reduce one side to 4, you reduce the opposite to 4, and so on, which enables you to remove the last petal and win.

Answer to "While You Wait"

The cobbler charged 90c. for repairing men's shoes, 75c. for women's and 45c. for children's.

Answer to "Reversing Magic Squares"

The diagram shows how the 9 little squares are constructed of four similar continuous lines. The diagram also shows an arrangement of the 9 figures in which totals of the 8 rows are dis-similar

SOLUTION

3	2	7
8	5	9
4	6	1

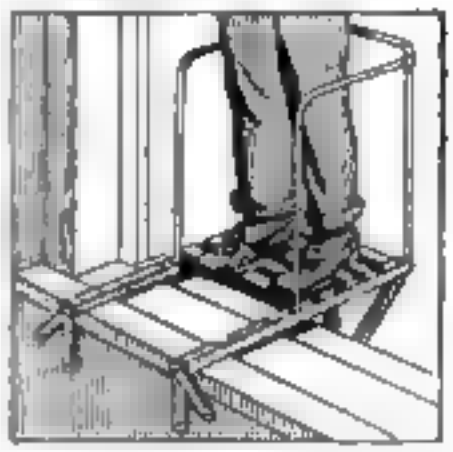
Little Inventions to Make Life Easy

Why Weren't They Thought of Before?

Small Electric Heater

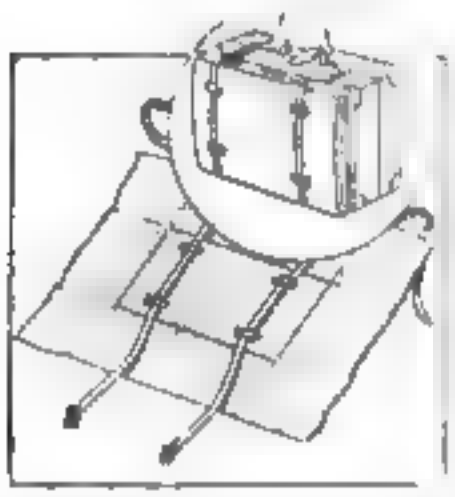
THE electric heater shown in the illustration is very serviceable for quickly heating small quantities of water or other liquid in a suitable vessel. The large heating surface insures very quick action. An easily detached connector adds to the convenience.

Safety-First for Window-Cleaners



A SMALL platform is clamped to a window-ledge to serve as an extension to the outer sill. This gives a wider foothold outside the window and materially increases the safety with which window-washing operations may be undertaken on high buildings. A railing around the top of the platform lessens the danger of a chance miss-step.

Packing the Things You Never Can Cram into Your Suitcase



THE attachment fits the side of a suitcase and is meant to increase the capacity of the interior. The central rectangle is made of stiff material, while the side-pieces fold in on it, completely covering whatever is placed inside The neat, flat bundle thus made may then be fastened to the side of the suitcase with tie straps provided for the purpose.

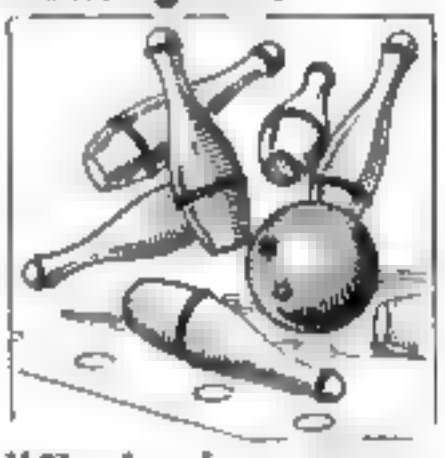
A Mitten-Duster

A MITTEN-duster which can be slipped on the hand enables the housewife to dust furniture as with the ordinary dust cloth and at the same time keep her hand perfectly clean. The mitten consists of a hand-shaped piece of soft felt; a bunch of cotton yarn is attached to the lower edge and serves to gather the dust.

The Fruit Picker's Sleeve-Chute

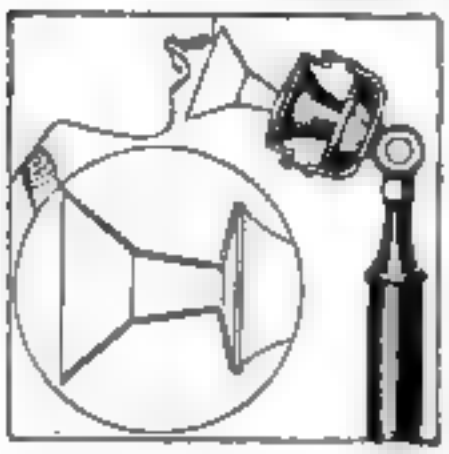
ATTACHED to the wrist of the operator is a sleeve. Fruit grasped by the hand slides down the cloth tube and into the bag. The fruit-picker's other hand is thus left free to grasp a ladder, tree-branch, or other support. Much time is thus saved over the older method of holding a pail or basket with one hand and dropping picked fruit into it with the other.

Muffler for Bowling-Pins



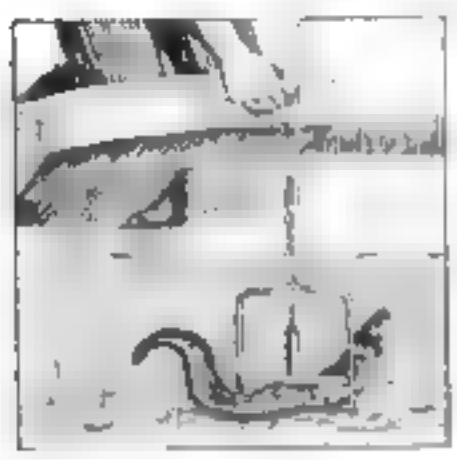
THE noise made by falling bowling pins is a nuisance, especially when the alleys are in the vicinity of a hotel or other place where quiet is desirable. This difficulty is overcome in large part by cutting a groove in the belly of the pin and in the top, and then putting in place a rubber band to deaden the sound made by the falling pins. This acts effectively as a muffler and reduces insomnia in nearby places to a minimum.

Telephone-Mouthpiece Deadens Outside Sounds



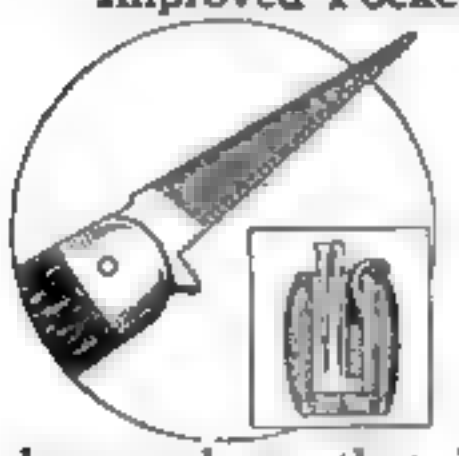
THE added mouthpiece shown has a second diaphragm attached to its inner end. This absorbs the outside noises which interfere with telephone conversation. Through a central hole in this outer diaphragm sounds spoken into the mouthpiece are carried to the inner diaphragm in the ordinary manner. The invention is particularly useful in mills and factories where pounding and noise make it impossible to telephone with ordinary apparatus.

Down with the Portcullis, and Your Fish Is Caught



THE fisherman plants his trap in paths frequented by fish. When the prey swims through the metal archway, a quick jab on the handle causes the top cross-piece to descend, pinning the fish tightly to the spikes beneath. The catch may then be drawn up through the water and dropped into the boat.

Improved Pocket-Knife Punch



A NEW pocket-knife has a blade L-shaped in cross-section. It is especially adapted for use as an awl or punch. The inner edge of the punch is sharpened, so that it can be used in reaming out and cutting into a hole. Slanted corrugations on the blade's exterior assist it to penetrate hard substances, since they grip the material screw-fashion. The new punch is no more in the way than the ordinary knife-blade, since it folds compactly into the handle when not in use.

A Magnifying Needle-Threader

ALMOST every professional or home seamstress, as she approaches middle age, begins to have trouble to see well enough when threading her needle. There has been devised an adaptation of the magnifying glass to serve her. A lens which will enlarge three and a half times is supported by a little standard fitting into the spool of thread. The glass can be turned to any desired position as the seamstress looks down through it at her needle and thread. The lens is also available for other purposes, such as removing splinters, or studying fine print or small pictures or maps.

Mattress Handles Lighten Housework

TWO rectangular wire frames, hinged together at the middle, are fastened to the mattress with heavy safety pins or any other convenient means. A handle is located near each corner of the mattress; other handles are provided in the center if necessary. By grasping the handles a housewife can move a mattress much more easily than by seizing the bulky cloth itself.

A Perfume-Wafting Fan

CONTAINED within a fan-handle is a layer of cotton or other fabric, while at the top of the blade is a strip of blotting paper clamped across a hole. On both these absorbent materials perfume is poured. As the fan is swayed in the air the perfume is given off. Because of the novelty of the idea, the fans are advanced as a valuable advertiser for perfumes.

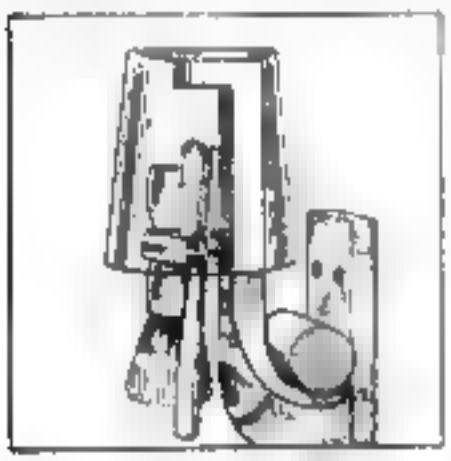
An Umbrella with an Electric Fan

HERE is an umbrella with an electric fan to keep you cool on a hot day. Within the hollow handle of the umbrella are concealed both a dry battery and a motor. A shaft extends through the umbrella casing from the motor to the axis of the fan, which is so constructed that the blades open and close with the umbrella. By pressing a small push-button at the side of the handle, the fan blades are made to revolve as long as pressure on the button is maintained.

Two Kitchen-Forks in One

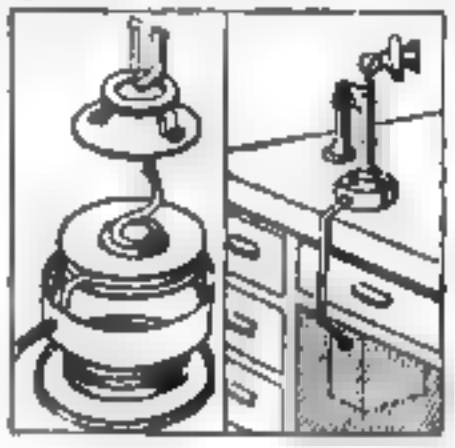
A DOUBLE kitchen fork that meets one of the housewife's troublesome problems is shown in the cut. In taking vegetables, tender meats, and other similar foods from the pan it is customary to use two forks, one in each hand, in order to prevent breaking the food into small pieces. The double fork enables one to make the transfer with only one hand, leaving the other hand free for handling the utensils and for other purposes.

Convenient Holder for Toilet Articles



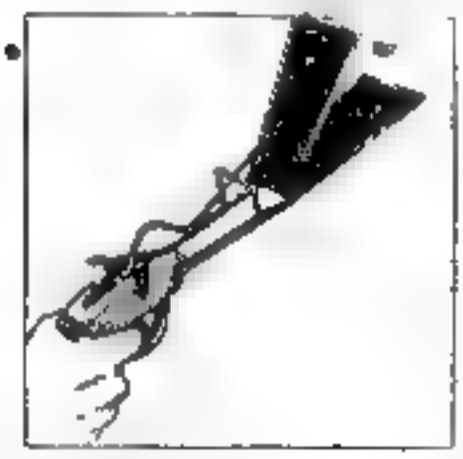
A CLAMP, fastened to a wall, has a notched lug for gripping a toothbrush, shaving-brush, and other toilet article. A glass, placed over the top to keep the dust off, is readily removed at any time. In the hollow of the arm back of the glass a shaving stick may be deposited, thus making the whole a compact and convenient fitting for crowded bathrooms.

Cord Reel Is Telephone Convenience



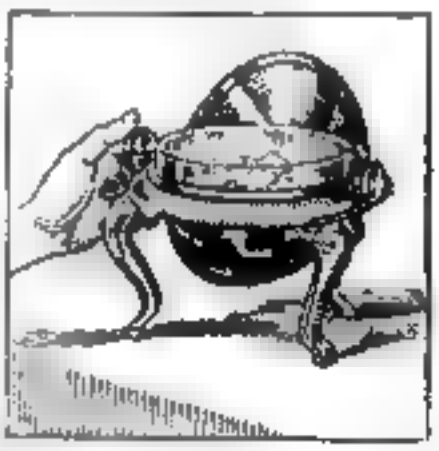
TO take up loose telephone cord and prevent it from getting entangled with desk materials, a reel is actuated by a spring, having just enough tension to keep the cord wound up but not sufficient to move the telephone. The attachment will fit any ordinary desk-telephone. The spring is the lowest of the three coils shown in the illustration, the cord being the others.

The Mechanical Fly Swatter



TWO mesh screens such as are used on ordinary fly killers are pivoted so that when a trigger is pulled, a spring causes the two screens to come together like the jaws of a trap, thus catching the fly between the two screens and crushing it. The handle of the device is shaped like a pistol stock, and the spring mechanism is actuated by a trigger, as in a pistol. If desired, the two screens may be locked together, and the device used as an ordinary fly "swatter."

A Sanitary Butter Dish



A SANITARY butter dish protects the butter from dirt, dust, and flies, and at the same time keeps it cool and solid. The butter is contained in the tray of crystal glass; beneath is an ice chamber in which ice may be placed in warm weather. The cover is turned over the butter to protect it when the dish is not in use; when the butter is needed the cover easily swings into place underneath the glass. This dish is not only convenient and useful, but ornamental as well.

For Practical Workers

Curing a Noisy Automobile Hood

MANY of the cheaper cars develop an annoying series of noises after they have been in use for a time, and most of these may be entirely eliminated by a little careful attention. The most common cause, outside of the mechanical depreciation, is looseness at the hood, as this rubs against the hood-ledge on the radiator and dash, and produces squeaking. The hood is liable to rub on the filler-board between the frame and hood side, as the frame distorts due to highway irregularities, and if the hold-down clips are loose, the hood will rattle.

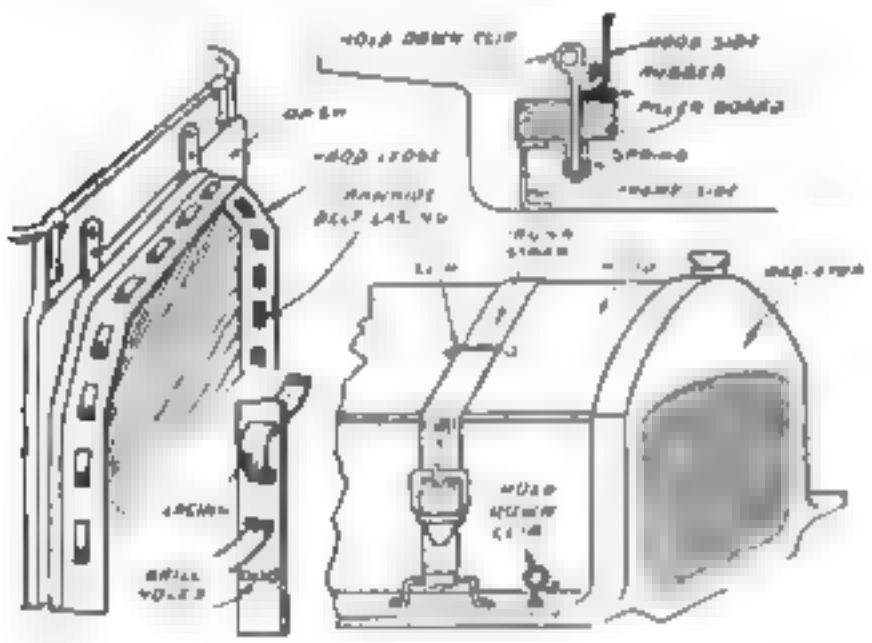


Diagram showing the use of rawhide to prevent hood from rattling

A very simple method of overcoming this trouble is to remove the strip of shoe-lace or light webbing ordinarily used on the hood-ledge and substitute for it, a good, broad, rawhide belt-lacing. The webbing is not heavy enough to keep the hood away from the ledge and soon flattens out. The rawhide is not only thicker and broader, but it is more enduring. In order to use the lacing, the small holes in the ledge-strip must be enlarged, which can be done very easily by making a drill hole on each side of them and then punching out the metal with a chisel.

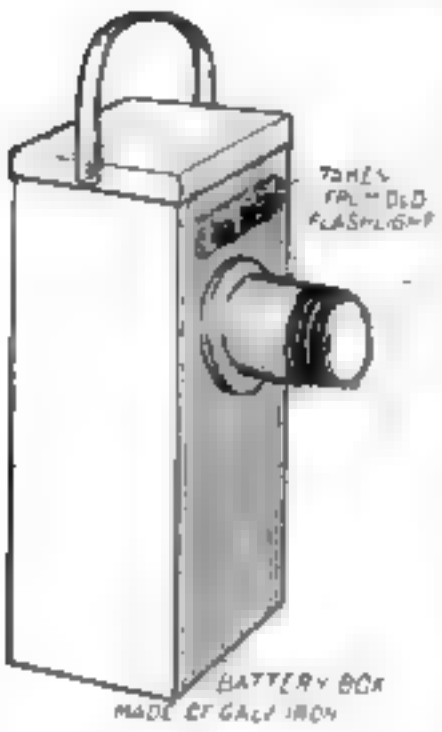
Another good way to cure hood rattle, which is unavoidable with thin gage hoods, is to run a trunk-strap over the hood as shown. This should have a series of holes for the buckle at each end, the buckles being carried by shorter straps attached on each side of the car, so the hood can be raised on either side without entirely removing the strap. The strap is guided by clips riveted to the hood, the straps carrying the buckles being held down by clips fastened to the filler-boards. Much improvement can be made by interposing a thin strip of rubber from an old inner tube between the hood side and filler-board as shown. The springs regularly furnished to seat the hold-down clips can also be replaced with stronger ones.—VICTOR PAGE.

A Long-Handled Screwdriver

A LONG-HANDLED screwdriver can be constructed in a few minutes with a block of wood, a piece of ½" pipe and a dowel ½" x ½". A slot is sawed in one end of the pipe to prevent the screwdriver from turning. The accompanying diagram illustrates the construction. Any length screwdriver may be constructed by the variation of the length of pipe used.

A screwdriver of any length can be constructed with a block of wood, a piece of pipe and a dowel

Making an Electric Lantern from a Flashlight



A SMALL tubular flashlight of the double tungsten battery type, of about 1¾-in. diameter, may be converted into lantern form at a small cost. The regular type of dry battery is used, being cheaper and more durable.

The body of the lantern is made of galvanized iron. Its base is 3¼ ins. by 3½ ins. square, and its height is 9 ins. Two 10-32 machine screws are let through two opposite sides near the top, and soldered in place. The handle is drilled at each end, slipped over the screws and fastened on the outside with small brass nuts. Two notches are made in the cover to enable it to set down over the screws.

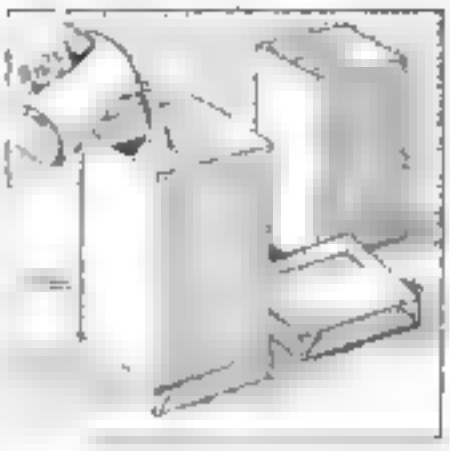
The lens, metal ferrule and cap are removed from the fiber body of the flashlight and soldered to the front of the battery box, as shown in the illustration. The switch may be used by mounting it as shown. One terminal of the battery is grounded to the box; the other runs to the switch and from there to the bulb. After giving the box a coat of black enamel, the lantern is finished. It is in many ways an improvement over the original flashlight.—A. DANE.

Driving Screws in Inaccessible Places

DRIVING a set-screw in a place too small to admit the fingers to hold the screw may be accomplished as follows:

Roll a piece of paper into a cornucopia with the hole just a trifle smaller than the screw. By dropping the screw into this and holding it in the hole with as light pressure on the screwdriver you can drive the screw home.

A Home-made Ice-Mold



TO help reduce the high cost of living, many people would freeze their own ice during the winter months if they had molds that were practical and inexpensive. Get at a furnace shop an old hot-air pipe, the larger the better. Cut into sections about two feet long and press into square tubes to afford a chance for the expansion of the freezing ice. For each tube or mold, make a pan for it to set in by bending up the four edges of a sheet of tin, making the pan about two inches deep. Fill the pan with water, place a tube in it and the first night's freeze will give a solid ice bottom. Add each day as much water as will freeze hard, till the mold is full. Put into the refrigerator, without removing from the mold. As many tubes can be used as desired or convenient.

How to Etch a Water-Set

THE easiest method of frosting glass is by means of hydrofluoric acid. A complete water-set can be beautifully etched with very satisfactory results.

Procure a water-set of any description; the quality of the glass makes no difference with the frosting process. Dip each piece in melted paraffin, being sure that every point is covered. After cooling, inscribe, with a knife-blade or etching-tool, the letters or design to be used, and see that the wax is entirely removed from the design.

Place all the pieces in a box, lined with heavy Manila paper. Also set a bottle of hydrofluoric acid in the box. Do not remove the acid from the original container, since it will eat through glass; simply remove the stopper and place a cover over the box. The fumes of the acid will act on the glass so long as exposed. From 36 to 48 hours give a good heavy frosting.

This method can be used on electric bulbs, glass doors or any glass that can be properly exposed to the hydrofluoric acid fumes. The acid will keep for months.—L. E. FETTER.

Grinding Out Dies

AFTER continued use, dies sometimes require a little more clearance. A grinding attachment for this purpose is shown in the diagram. The coupling is fastened to a small motor-shaft. A piece of drill-rod, ⅛" in diameter is attached to the other end of the coupling, and a small piece of metal is forced on to the end of the wire to form a shoulder for the wheel.

Using a wheel with a diameter as small as ¼", and having it mounted on the slender rod, which acts as a flexible shaft, it will find its way to small places that otherwise could not be reached without a stone.

Diagram showing simple appliance for grinding out dies

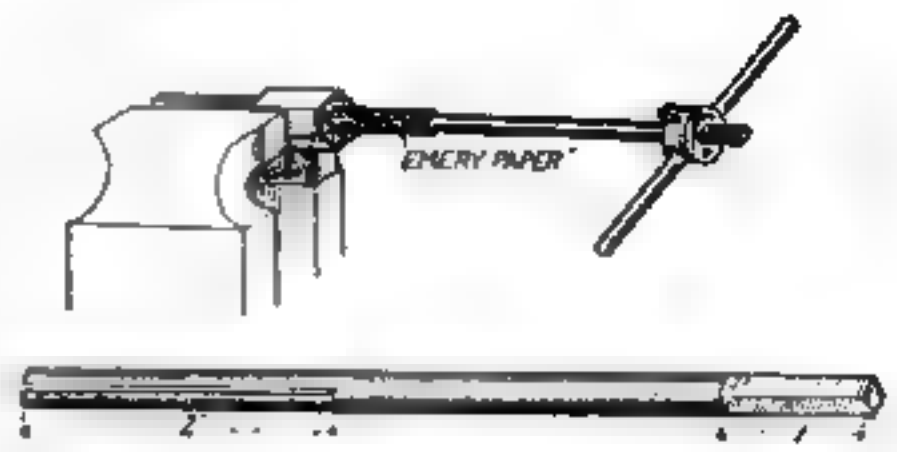
Drilling Holes in Sheet Metal

IT is very difficult to drill holes in even fairly thick sheet metal and practically impossible in thin metal, especially brass and copper. The following method will be found serviceable:

Drill a hole of the desired size in a piece of steel of suitable size. Square off the shank end of the drill and place the point in the chuck clear to the top. Close the jaws lightly so as not to injure the drill. A piece of drill rod with the end squared off is better, this piece constituting the punch.

Lower the punch and place the steel so that the punch enters the drilled hole. If the punch is raised carefully the hole will remain directly under the punch. Hold the sheet metal up against the punch; then lower both at the same time. They will not disturb the steel block underneath, when together. Additional pressure with the press-lever forces the punch through the sheet into the hole, taking with it a piece of metal the size and shape of the punch.

If the holes have a definite location, mark the center lightly with the center punch. Turn your punch in a lathe, leaving a small point in the center. By placing the center punch mark on this point, holes can be located with accuracy.



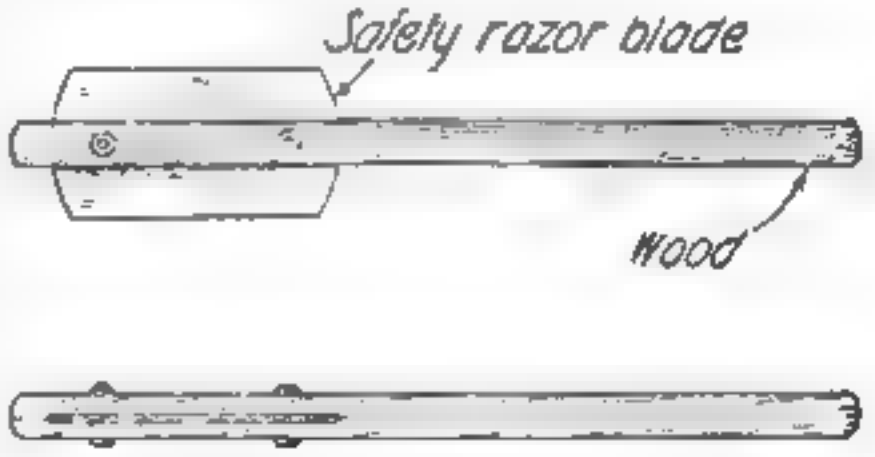
This reamer does accurate work and can be easily made

How to Make a Reamer

AN accurate and efficient reamer for enlarging steel or brass bearings, etc., can be made as follows:

Obtain a round steel rod and make a 2-inch slit at one end. File about an inch off the other end and square it so it will not slip in a brace. The length and diameter of the rod will depend upon individual needs and uses. Cut a strip of emery cloth 2 ins. wide. Insert one end in the slit in the rod and wrap the rest around it. The rod, with the emery cloth, is then inserted in the bearing to be reamed and turned by means of a brace.

This tool gives a smooth, clean, accurate cut and is much better than a round file for the same purpose. A set of these rods may be made from old pieces of steel that are found lying around most workbenches and will often come in very handy.



An old safety-razor blade is just the thing for making a scalpel

A Home-made Scalpel for Trappers

IN skinning animals, a very sharp knife is needed. A good scalpel can be made from safety-razor blades, as shown in the diagram. New blades may be substituted by removing the bolts. This tool is especially useful in dissecting skunks and muskrats.—E. S. CLARK.

A Hose Connection Guaranteed Water-Tight

THE hose connection illustrated, has an upper part with a tapered end to fit the rubber washer in the large end of the lower part. Near the end of each part, which engages the hose, is an enlargement to keep the hose from

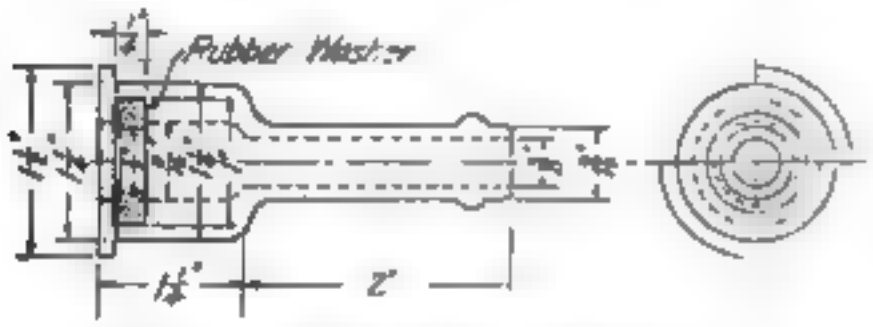
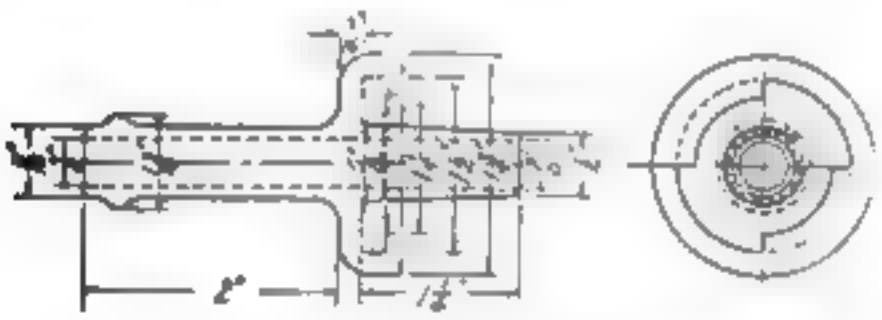


Diagram giving proper dimensions of hose connection

slipping off. Small clamps can also be used. Each flange consists of 2 segments of a circle, 90°, each opposite the other and tapered, or rather increasing in thickness, so that after the 2 parts are placed together, a 90° turn, and sometimes less, will make the connection perfectly tight.—JOSEPH K. LONG.



A ninety-degree turn makes this connection perfectly tight

Silver-Plating Glass

HERE is a good recipe for silvering mirrors or silver-plating glass of any kind.

Two solutions are used. For convenience they may be designated as solution No. 1, and solution No. 2.

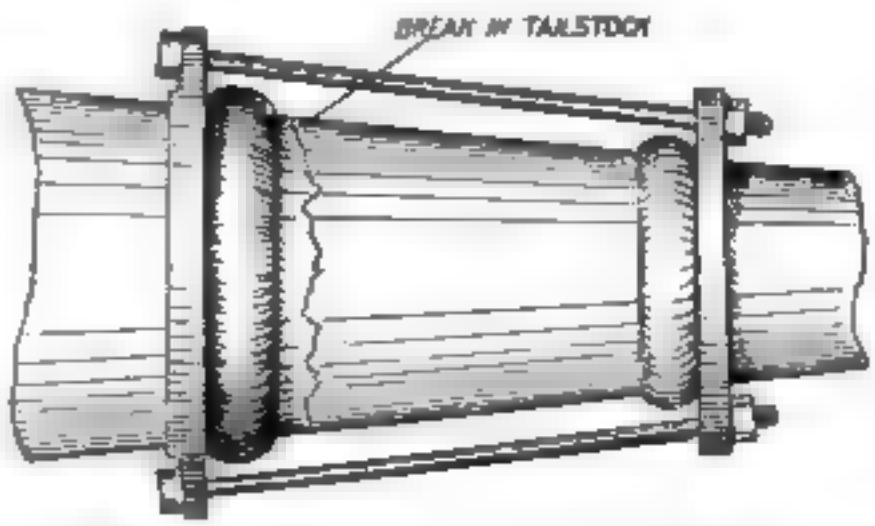
Solution No. 1 is prepared as follows: To a one per cent solution of silver nitrate add pure aqua ammonia, drop by drop, till the precipitate is almost all dissolved. Let this stand and then filter. The filtrate is solution No. 1.

To prepare solution No. 2: Dissolve one gram (.04 oz.) of silver nitrate in a little water and add to 500 cubic centimeters (17 fluid ozs.) of boiling water. Then dissolve 0.85 gram (13.12 grains) of Rochelle salts in a little water and add to the 500 cubic centimeters of boiling water containing the silver nitrate. Boil for 20 or 30 minutes till the gray precipitate has collected, and filter the solution. This filtrate is solution No. 2.

The glass surface to be coated must be carefully cleaned with alcohol to remove all traces of grease and dirt. All other surfaces which are not to be coated, should be painted with melted paraffin after the glass has been cleaned with alcohol. This leaves a clean exposed surface on one side of the glass to which the silver will stick. In coating with the paraffin, be careful not to get any on the clean surface. Mix equal parts of solutions No. 1 and No. 2, and place the glass to be coated in the solution. The silver will stick better if the clean exposed surface of the glass is rubbed with a small cotton swab, saturated with the solution. Leave the glass in the solution till the coating of silver is as heavy as desired. Then scrape off the paraffin, being careful not to mar the silver deposit on the rest of the glass. If desired, to protect the silver coating, two thin coats of white shellac may be applied.—L. G. HASKELL.

How to Mend a Broken Casting

WHILE placing a casting in his lathe, ten years ago, a machinist permitted it to drop on the tailstock, breaking the casting, as shown in the illustration. It was a serious break in those days, when cast-iron could not be welded so readily as now. The only recourse was a harness of two turned rings and two bolts. The arrangement may be seen in the illustration; it does not look good, but it is still doing service.—N. G. NEAR.

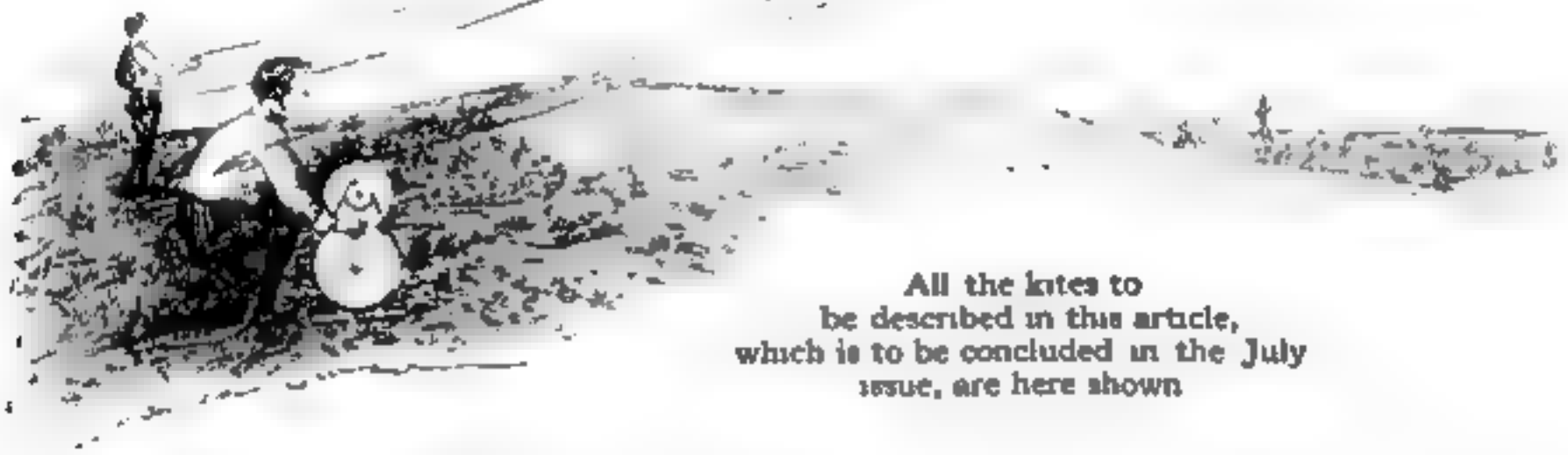


This mended casting has done service for ten years

Kite Making at Home—I.

How to Build and Fly the Malay, Blue Hill Box and Tetrahedral Cell Kites

By Harry F. Rinker



All the kites to be described in this article, which is to be concluded in the July issue, are here shown

THOUGH the kite is usually thought of as having four corners, with a grotesque face painted on each side and terminating in a tail of rags, the fact is that this sort of kite has disappeared. Today every boy who is scientifically inclined, can build for himself kites which are as much ahead of the one Benjamin Franklin used as the motor-cycle is an improvement over the bicycle.

Building the Malay

We will begin operations by making six-foot Malays, each of which carries 18 sq. ft. of sail, or 108 sq. ft. for the battery. The maximum pull from these kites is delivered at approximately 45 degrees flying angle, and the tangent of 45 degrees being .707, the resultant pull equals approximately 7/10 the horizontal wind force per square foot. With a ten-pound breeze, therefore, the pull of one kite will be 126 pounds, and six of them will pull 756 pounds. It is evident, therefore, that some mechanical advantage is needed by the operator to handle such a force as this, and such apparatus will be discussed later.

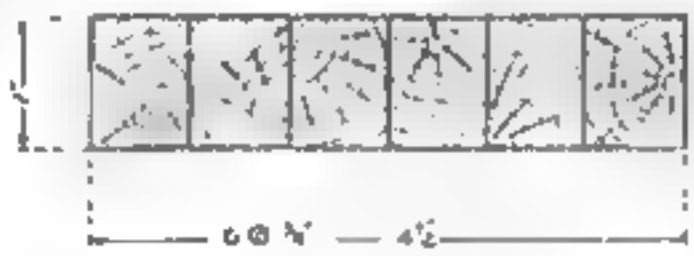


FIGURE 1

The design of the kite is as follows: The frame of this kite consists of two sticks at right angles to each other, supporting the sail. For the six-foot kite, the two sticks are each 6 ft. long. The vertical stick is placed keelwise, while the transverse stick is laid flatwise across it. The required size for the vertical stick is 1 in. by ½ in. and for the transverse stick ⅜ in. by ¾ in. Take a piece of clear white pine, spruce, or fir stock, 1¼ ins. thick, and split it once. Plane up the split edge to a straight edge, and rip off, parallel to it, six pieces ¾ in. wide. The majority of the fibers in each piece must run from end to end. Clamp up and plane off to 1 in. thickness, as shown in Fig. 1. Take apart and lay flat on bench as in Fig. 2, and dress to ½ in. thickness. Spring each piece carefully in your hands to see that it has uniform strength. Get your cross-sticks from 1 in. or ⅞ in. stock in a similar manner:

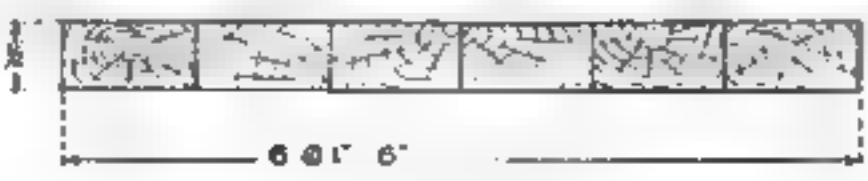


FIGURE 2

Dress them clear and clean with a good sharp plane. Now mark them as just described. Make six brass clips, of No. 22 or 24 gage brass, as in Fig. 3. Also make six as shown in Fig. 4.

The bolt in the clip on the upright should be tight enough to pull it into the wood, and the wires on the transverse stick should do the same so that clips will not slip, but at the time avoid bruising the wood more than necessary. The twisted ends of wire can then be turned in, and soldered. The ends of each stick should then be wrapped with several turns of wire, keeping about ⅜ in. from the extreme end. These wrappings should also be soldered. The ends of the cross-stick should then be notched for the bowstring, as in Fig. 7. The bowstring when applied should pull the cross-stick as in Fig. 8. Always leave the bowstring so it can be slipped. The distance X should be about 6 ins. for a very light wind, and about 10 ins. for a 10-mile breeze. If not satisfactory at first adjust after trial.

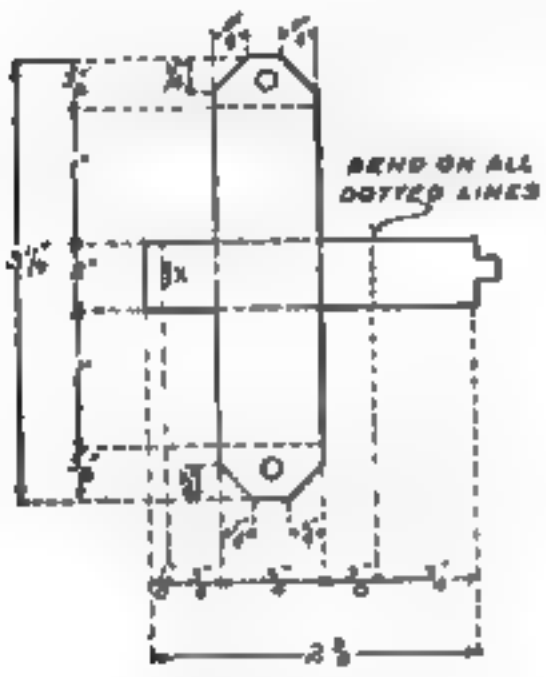


FIGURE 3

Finally make a saw cut about ¼ in. deep in the end of each stick, sawing the ¾-in. way on the cross-stick and the ½-in. way on the upright. Then take a string, strong enough to stand considerable pull, and pass around the frame through the saw cuts. Make a slip-knot where you join and hold in your hands or fasten temporarily. Square your frame by measuring this string till corresponding parts on each side are exactly equal, moving the sticks in relation to each other till you get the frame true. The cross-stick will now be exactly at right angles to the vertical, and the bowstring should pass about 10 ins. behind it.

The center lines of the two sticks must cross exactly 18% of the length from the top of the vertical stick. Be exact if you want your kite to balance. So, 72 ins. × 18% = 12.96 ins. = distance from the top. Mark 13 ins. with a pencil, and shade this slightly upward. Now mark the exact center of the cross-stick.

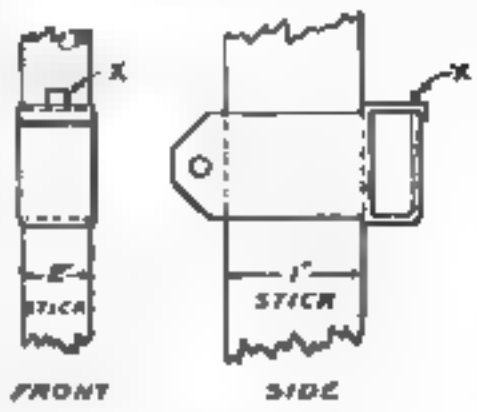


FIGURE 4

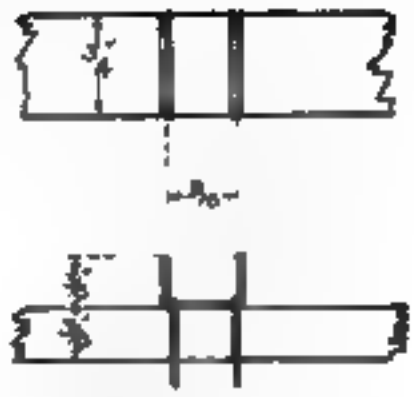


FIGURE 6

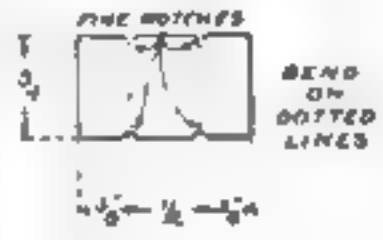


FIGURE 5

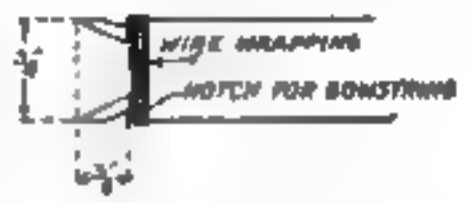


FIGURE 7

The best material for making the sail is known as silesia or cambric in the dry goods stores. Any combination of colors can be used if desired, but they must join in a straight line up the keel. Blue and yellow, white and red, green and pink, etc., are all strong contrasts. However, the colors seen most distinctly at great heights are red and white, black and white, orange and red, and blue and white. Whatever the colors you select, and plain ones are as good as any, start by marking out on the floor with chalk the four points of your frame. Sew your cloth firmly on a sewing machine, and lay it out as in Fig. 9.

Sew a brass curtain ring, 1 in. diameter, in each corner, so it can be hooked into the saw-cut. Tie a stout string from ring to ring, putting the rings in place on the frame and pulling into position till both sides are exactly the same

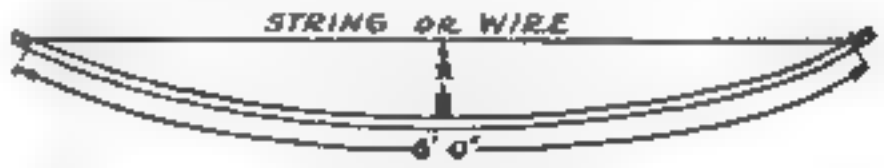


FIGURE 8

length. The extra length on the cross-stick must be fulled on the string toward the top of the upright so as to

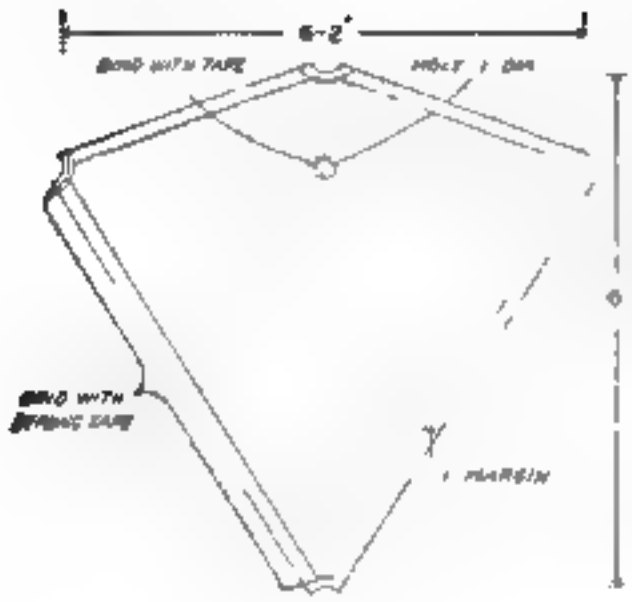


FIGURE 9

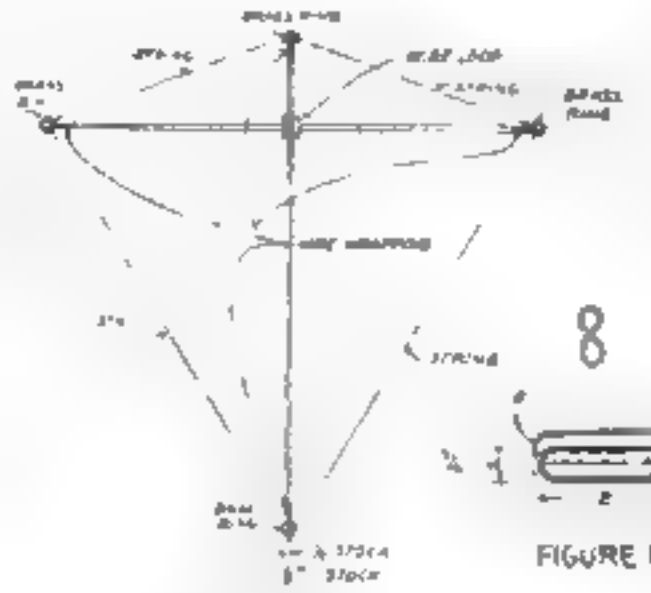


FIGURE 10

FIGURE 12

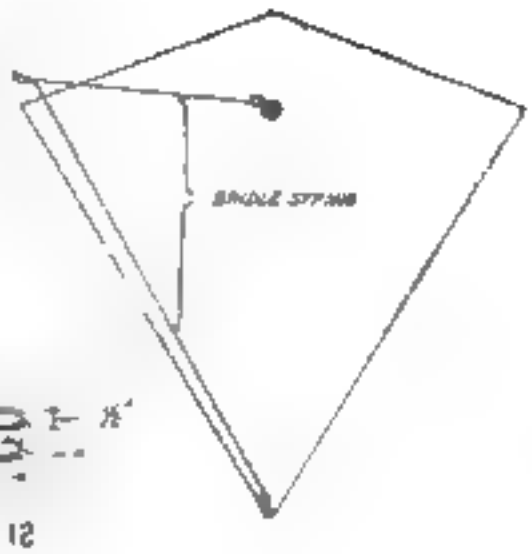


FIGURE 11

bring all the slack in the center. This forms a pocket under pressure, making the head-sail which keeps the kite from pitching. Turn over all the edges and sew them firmly and evenly. You will now have a cover with rings in each corner and re-enforced edge. Turn the raw edges in. Remember it is windy where this kite goes. To bridle the kite, get a piece of wire and bend it as shown in Fig. 12. Solder it into an endless loop. This must be slipped on as the sticks are put together, so that the loops marked *A* project through the 1-in. hole in the sail, while those marked *B* pass behind the upright stick. The bridle string is fastened by means of an S-link—as shown, at each end. One link is hooked into the loops marked *A*, and the other into the ring at the bottom of the kite. You now have a kite which when knocked down and the sail wrapped around the sticks, forms a package 6 ft. long and about 2½ ins. in diameter. You can carry six of them easily. You can get on a trolley car or boat with them without trouble, while, if not made as above you could not handle one. After a little practice, they can be put together in a few seconds, and they will carry a boat along in good shape at an amazing speed when properly flown.

The flying cord used by the writer was a steel wire No. 18 gage, in ½-mile coils, tested to 750 pounds. A special reel was used for this wire, with multiplying attachment, and smaller steel wires, No 22 gage being used for each individual kite.

The method of flying is this: A kite is set up, bridled, and hooked to one of the small wires, this wire paid out from an auxiliary reel, until 200 ft. are aloft. The main flying wire is then attached. When 400 ft. are aloft, the reel is checked. A second kite is flown with 200 ft. of lead wire and hooked into the main wire. Both kites are then paid out on the reel, till another 200 ft. is aloft when a third kite is flown and attached. This process is continued till all the kites in the battery are aloft. The reel used contains one mile of wire.

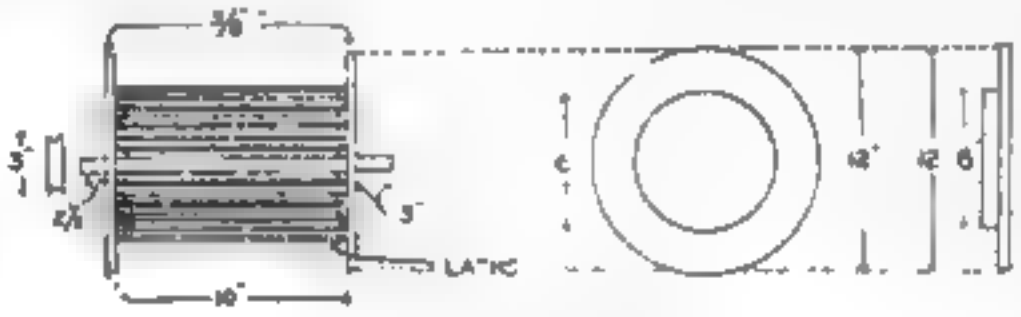


FIGURE 13

The method of attaching the kites to the main line may seem to the novice a means of inviting trouble but in practice each kite flies higher than the main line, and invariably some slight difference in balance or variation in direction of the wind at different heights sets them out from the main line at different angles, so that they do not interfere. Four of these kites in a 10-pound wind will give two-thirds the pull of six, as a matter of course. So if you had a 15-pound wind, four would be about all you could handle, while in a 30-pound wind, one would be fully capable of keeping you busy even if it did not break its back, for a 30-pound wind, blowing 80 miles an hour would give a total loading on

the vertical rib of 540 pounds, which is nearly the ultimate. It will not be necessary to demonstrate further than the figures given, that this kind of kite flying is strenuous enough to hold a man's attention when his whole battery is aloft in a 10-pound wind.

The reel is made of two circles of ⅞-in. material, 6 ins. in diameter. To one side of these pieces, other circles of ⅜-in. material, 12 ins. in diameter, are glued cross-grain, and further secured by a half-dozen clenched brads. To the inner 6-in. circles nail slats of ¾-in. material, 1 in. wide by 10 ins. long. Cut the holes in the center of the ends 1 in. square; put a square stick tightly through these holes, allowing it to project 2½ ins. at one end and 3 ins. at the other. Turn bearings for the frame in each of the projecting ends. These will be 1 in. in diameter. If you have no lathe you can whittle them with a knife and sandpaper. The frame is made, as shown in Fig. 13.

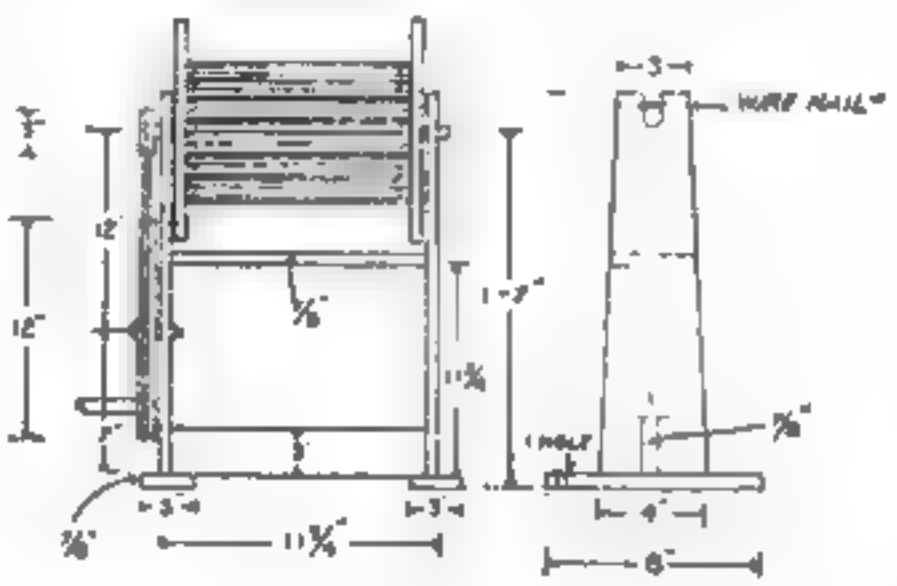


FIGURE 14

Obtain two grooved pulleys of the diameter shown and a piece of sewing machine belt. Put the belt on the pulleys crossed. This will give it better contact. Screw into the 12-in. pulley a handle about 1½ ins. from the edge, and you have a good stout reel which will bring your string in four times as fast as an ordinary reel. You will appreciate this when you have tried both. No checking arrangement is needed on your reel. When necessary to check, take the string in your hand and snub around the projecting end of the axle. Two iron pins, 15 ins. long, of ½-in. round iron, pushed slantwise toward the front through the 1-in. holes into the ground, will take the strain.

The construction and methods of flying the Blue Hill box-kite and the tetrahedral cell will be discussed in the next issue of the POPULAR SCIENCE MONTHLY.

How to Protect the Surface of a Laboratory Table

STRONG acids and other chemicals of strong composition are continually spoiling the appearance of laboratory tables. The following treatment may therefore be found of service. It can be recommended for preserving the experimenting table from the injurious effects of strong acids or alkalis that may be accidently spilled, provided the liquids spilled are not left on too long. Two solutions are required, as follows: The first one consists of one part of bluestone dissolved with one part of chlorate of potash, in eight parts of boiling water.

For the second solution, dissolve 1½ parts aniline hydro-chloride (which a chemist can obtain to order), in 10 parts of water. Having thoroughly cleaned the table, apply the first solution as hot as possible, and with a flat brush. Apply another coat as soon as the first is dry, and then two coats of the second solution. When thoroughly dry, rub with raw linseed oil, till polished, and wash with hot, soapy water. A good black surface is thus given to the wood, in addition to the acid-resisting qualities. After it is perfectly dry, a little linseed oil, applied with a cloth, will also be of advantage. A hard surface with considerable luster is thus obtained, which will resist damage to its surface, especially from acids.—WM WARNECKE, JR.

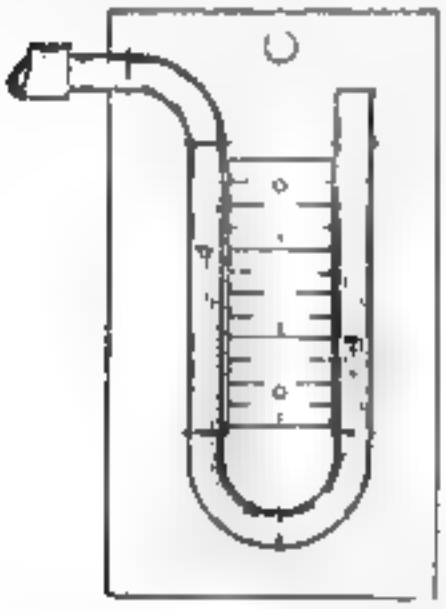
A Mission Stain

ONE of the best and cheapest stains for mission furniture can easily be made by mixing black asphaltum with turpentine. Any desired brown shade can be obtained by varying the amount of turpentine. Apply the mixture to the work with a brush. After it has been on a minute, rub it dry with a clean cloth or cotton waste. It will dry quickly and leave a dull mission finish.

Gaging the Stack Draft

THE draft pressure of a stack is expressed in inches of water, meaning the amount of draft required to change the difference of equilibrium of two communicating columns of water, measured in inches.

The draft of the chimney can be easily obtained with the use of the little gage illustrated herewith. The fuel consumption of a boiler can be figured whether or not it is in proportion to the results, etc. The illustration shows how such a gage is made. A single length of glass tubing with an inside diameter of ¼ in. is bent to the required shape by holding over a small flame and bending very slowly when hot. Fasten to a board with wire or brass straps. Arrange a scale of inches between the two columns.



Glass tube used for gaging stack draft

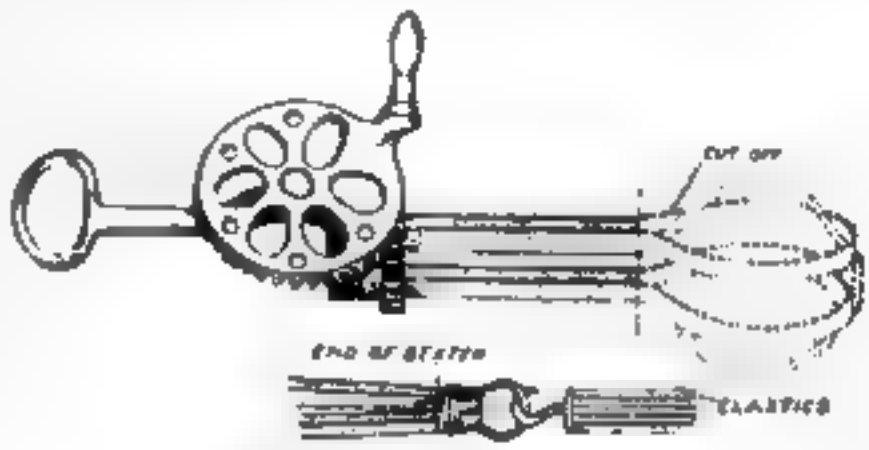
To read the draft, place the gage on a wall in a vertical position and put a little water into the tube so that it just balances in either column. Connect a piece of rubber tubing to the left leg and seal in a small opening in the stack or pipe. The draft or suction at the end of the tube will cause a slight vacuum in the tube and will cause the two columns of water to change their level. The draft may vary from ¼ in. to 2 ins. according to height of stack, temperature and weather conditions. The draft pressure required will depend upon the kind of fuel used. Wood needs little draft, about ½ in. or even less. Bituminous coal will require ¾ in. to 1 in. and anthracite or slack will need a draft of 1½ ins.—B. F. DASHIELL.

A Safe Way of Bending Pipes

THOSE who try to bend piping without kinking by filling the pipe with sand and still fail, will attain better success if they pour molten lead into the pipe, allow to cool and then bend. Heat the pipe, allowing lead to flow out.

A Toy Rubber-Elastic Winder

A DISCARDED egg-beater may be easily converted into a toy aeroplane winder. Cut off the loops which formed the beater part. Wire the stubs together and make two wire hooks or loops for fastening the rubber bands. The winding will be greatly facilitated by increasing the length of the crank.



An old egg-beater can be converted into a good toy winder for rubber motors

A Cheap Beam-Compass

A WOODEN rod, such as drygoods merchants use for cloth, makes a good beam-compass, by attaching a pencil and nail as shown in diagram. The pencil is flattened on opposite sides, to be gripped in the beam, and the head of the nail has been filed off. The rings consist of brass tubing. When using ink, the ruling-pen is gripped like the pencil.—WM. TURNPENNY.

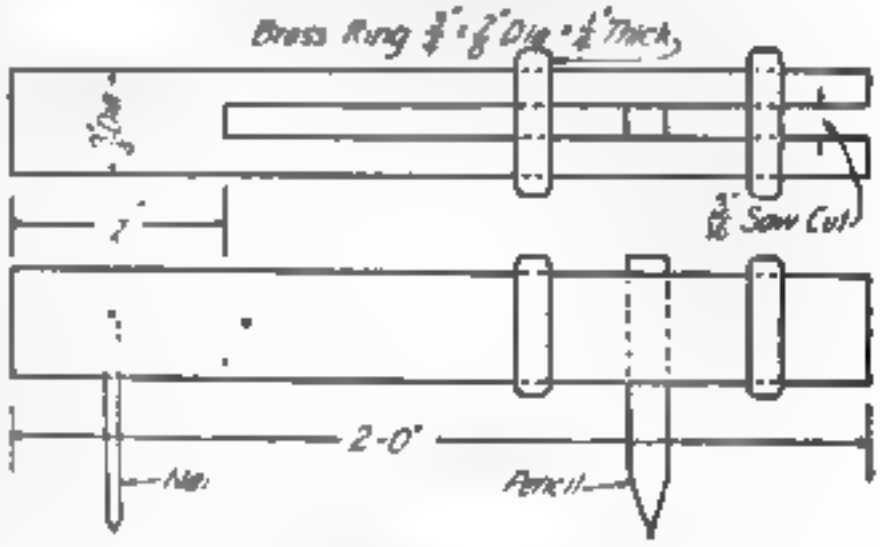
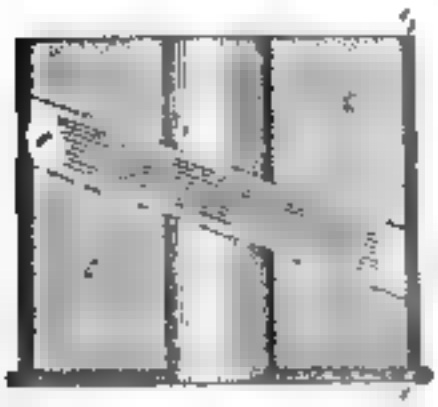


Diagram showing construction details of beam-compass

Removing Waterproof India Ink Spots

IT is not generally known that black India ink, especially the waterproof kind, may be removed from nearly any material by placing a blotter underneath and pouring household ammonia over the dried ink. Care should be taken that the blotter does not become saturated with the blackened ammonia.

How to Make a Polariscope to be Used with a Microscope



MANY microscopic objects that appear uninteresting and devoid of structure when examined in the ordinary way, develop surprising beauty of form and color when viewed by polarized light. This applies to the majority of crystals and rock sections, as well as many vegetable sections containing minute crystals embedded in the tissues. A beam of light may be polarized by passing through a specially cut prism of Iceland spar, or more cheaply, by using a bundle of glass plates inclined at a certain angle. The polarized beam is allowed to pass through a transparent object and afterward through a second prism or bundle of glass. The polariscope will therefore consist of two parts, one placed beneath the stage and called the polarizer; the other somewhere above the object, and called the analyzer. The best position for the analyzer is usually considered to be just inside the body-tube of the microscope, immediately above the objective. A low-power objective measuring about 1 in. is best when working with polarized light.

The accompanying illustration shows the details of the polarizer in section. The several parts may be mounted in a brass tube *A*. Any tube that happens to be handy will do, but it must make a nice fit in the understage fitting of the microscope, so as to be capable of rotation without danger of falling out. A paper tube can be used as a substitute, though of course it will be less durable than metal. If paper is used the tube should be made by coating one side of a strip of paper with thin glue or good strong paste and winding tightly around a rod or tube of suitable size, care being taken to prevent the formation of wrinkles. If several layers of paper are wound on, the tube will be hard and strong when dry. One end must be closed with a cap *B*, perforated in the center with a hole ⅛ in. in diameter and projecting sufficiently beyond the tube to afford a convenient grip.

Two pieces of cork *C*, *C*, must fit neatly in the tube. Each of these must be cut as shown in the illustration, the slanting sides forming an angle of 57 degrees with the side of the tube. Further, both corks must be perforated with a hole of the same size as that made in the cap *B*. The holes should be carefully made with a cork-borer so that they will be continuous when the parts are assembled, and parallel to the axis of the tube. They should be blackened inside with photographic dead-black, or else lined with black paper having a dull surface. After fixing one cork by means of fish glue, a number of thin microscopic cover-glasses *D* should be dropped in, each of which must first be cleaned thoroughly with tissue paper or chamois leather. About 18 will be sufficient. They are best handled with a pair of small pointed forceps. The second cork can then be inserted, a gentle pressure being applied to keep the thin glass plates from moving and so rubbing dust off the corks.

The analyzer is merely a replica of the polarizer, but small enough to go inside the body-tube of the microscope. In this case it will not be necessary to have a cap at the end of the tube, since, if the polarizer rotates, the analyzer does not need to move.

A polariscope made in this way is inexpensive and the results, though somewhat inferior to those obtained by the use of Iceland spar prisms, will repay the trouble of preparation. One or two selenite films should be purchased, mounted on microscope slides of the ordinary size, 3 ins. by 1 in., and placed immediately beneath the object. By this means, the range of color is greatly increased.—H. T. GRAY.

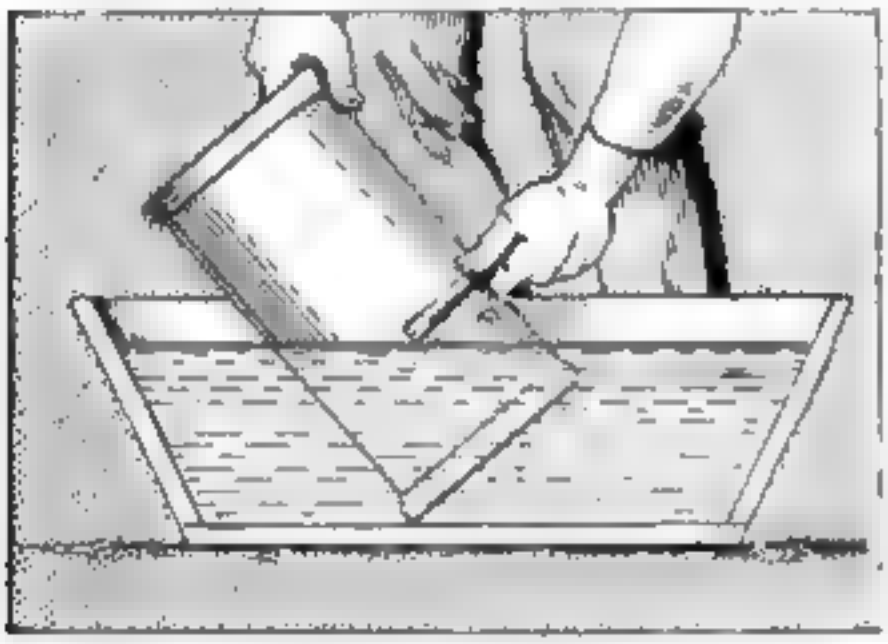
To Stop a Lathe Quickly

WHEN polishing or turning small diameters in the lathe it is usual to speed the lathe up to its limit. This is all right, but in stopping it is the custom to throw the belt shifter quickly, which often causes the reverse clutch to be engaged; and if it happens suddenly the result is that the belt comes off. This trouble can be easily prevented by placing a collar on the shipper rod which will prevent the reverse clutch from engaging.

Cutting Tile at Any Angle

IT is often desired to cut tile, cast-iron pipe, or even steel pipe at an angle in order to make a turn in the pipe line. Where these pipes are so large (as they usually are) that they cannot be laid in a miter box for cutting, and where it is desired to mark them quickly and correctly at the same time, the following is a good expedient:

Set the tile in water at the correct angle, as shown in the diagram; hold it there and make chisel marks all around at the surface of the water. The cut can then be made, after removing the tile from the water, in a true plane. Where care is taken in lowering the tile into the water so that it will not be wetted too high, the "wet edge" on removal will serve as a good guide for the path to be cut.—W. F. SCHAPHORST.



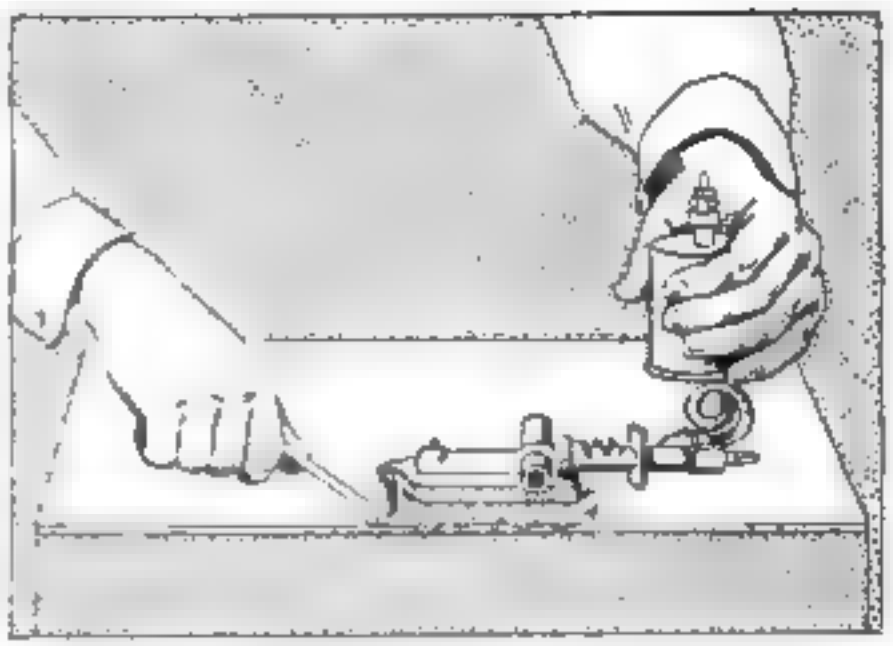
Piping and tile may be easily cut at any angle by dipping in water

A Substitute for a Soldering Iron

IT is often necessary to repair a leaky wash-boiler, tea-kettle or other utensil quickly, and if no soldering iron and appliances for heating it are at hand, the work must be taken to a tinsmith.

Moreover, a small soldering iron in the hands of an amateur is a difficult tool to use on large work because heat is rapidly conducted from the iron by the cold sheet-metal upon which it is used.

In many households may be found self-heating flat-irons. As shown in the drawing, the burners from such irons may be used to good advantage for soldering. Since the flame is directed downward by the pressure from the



A good substitute for a soldering iron is made from the burner of an ordinary self-heating flat-iron

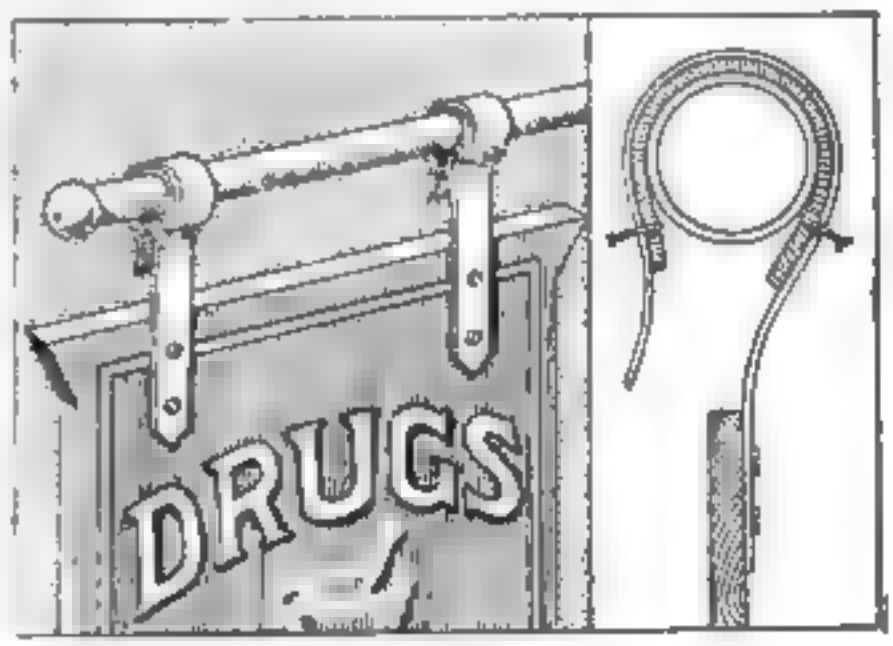
tank, the principle is essentially the same as that employed when using an alcohol lamp and a blowpipe.

A heavy copper wire may be used in place of a soldering iron. If the wire is short, it will be necessary to place it in a handle or wrap some sheet asbestos around one end, as it will become too hot to handle. This "soldering iron" will remain hot until you can finish the job.—C. H. PATTERSON.

Taking the Squeak Out of a Sign

INSTEAD of being kept awake nights by a squeaking drug store sign, the writer resorted to the following expedient to silence the offending advertisement: Insert two pieces of leather strap between the iron pipe which supports the sign and the strap-iron hangers, as shown in the diagram. Fasten the ends of each by twisting soft iron wire around the hanger.

No oil is needed and the leather will wear for a long time.



The squeaking drug store sign can be silenced with two pieces of leather

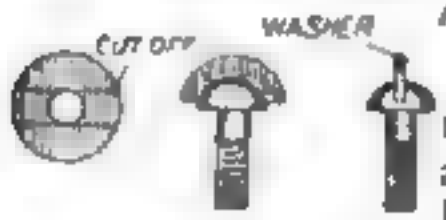
Handling Fine Screws

IN repairing watches, clocks, spectacles and other small articles, the difficulty of inserting very fine screws into their respective holes may be easily overcome with the aid of a piece of paper.

The screw is first pierced through a strip of stout paper, which is then held, with one hand, over the hole, while the screwdriver, held in the other hand, gently presses the screw into the required position.

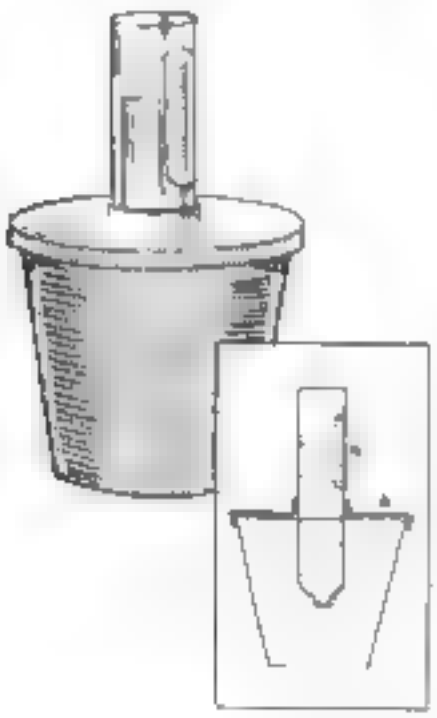
When the screw is partly driven, the paper is torn away and the screw finally driven home.—GEORGE H. HOLDEN.

A Home-made Thumb-Screw



THE materials needed for making a thumb-screw, are a round-headed screw and a washer. Cut the washer as shown and sweat it into the slot of the screw. If the washer is a good fit, very little soldering will be necessary to insure a perfect union.—L. E. FETTER.

How to Make a Barometer

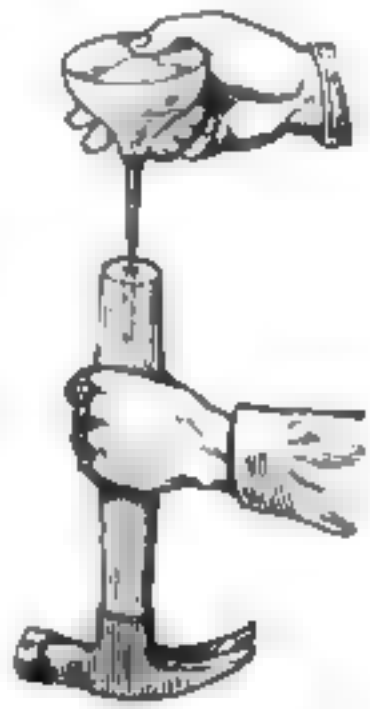


A SIMPLE but reliable barometer may be made from an ordinary tumbler and a test-tube or vial. The vial, about two-thirds full of water, is inverted in the tumbler, which is nearly full of water. A tin cover *A*, provided with a hole in the center, will serve to support the vial in an upright position. The greater the pressure of air, the higher the water will rise in the bottle, and vice versa. A little paper scale, ruled as shown, may be attached at *B* to indicate the degrees of fluctuation.—H. J. GRAY.

Making a Long Distance Shot with a Shotgun

IT is sometimes necessary to take a chance on making a long shot, in shooting into a large flock of ducks, especially in hunting on water. Cut a shell into two pieces, making the cut between the shots and powder as indicated in the illustration. If you have made the cut in the right place you will have a wad left at each end. Now put the portion of the shell containing the shots into the gun chamber and then put in the portion containing the powder. Of course your gun must be an open-bored gun. When you fire, the portion of the shell containing the shots will travel the same as a bullet, but upon striking the water it will burst and the shots will scatter in every direction, and you are sure to bag some game that would be otherwise impossible to reach.

Oiling Hammer Handle



A HAMMER handle which is well oiled will outlast two ordinary handles, as the oil penetrates the wood rendering it springy and also preventing dry rot. In the accompanying illustration is shown the methods by which a hammer handle may be thoroughly oiled. A ¼-inch hole is drilled in the end of the handle for a depth of about 2 ins. The hammer is then put in an upright position, and the hole filled with lubricating oil. When the oil has soaked into the wood, fill again, repeating the operation until the handle is well oiled. If desired, a small wooden plug can be driven into the hole to keep the oil from leaking out before it has completely soaked in.—O. B. LAURENT.

How to Build and Sail a Small Boat—II.

By Stillman Taylor

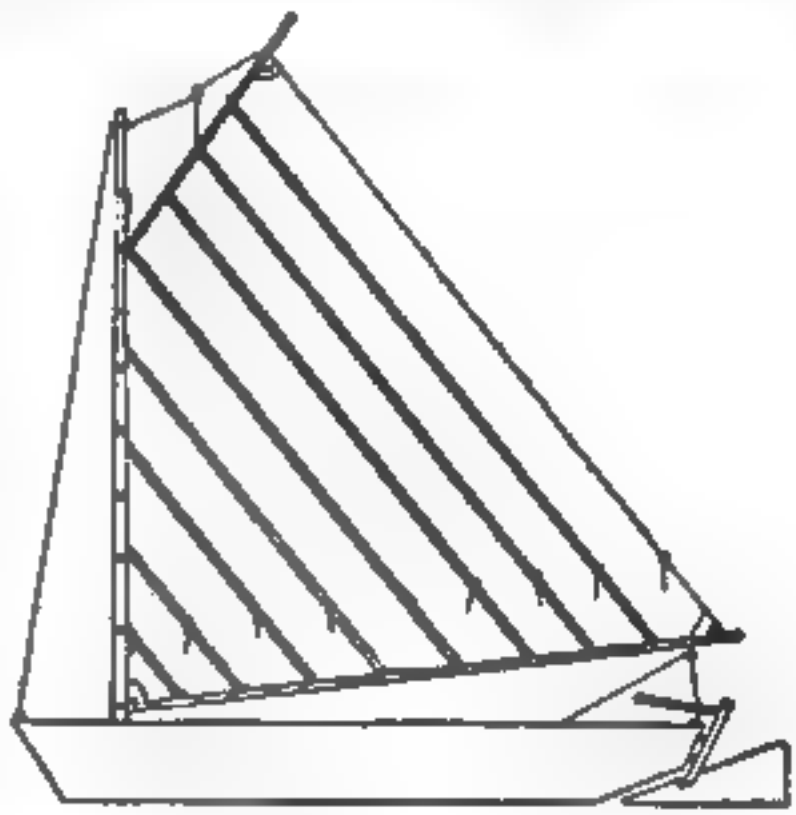
(Concluded from May Issue)

IN rigging the boat with a single sail, known as "cat-rig," the mast should be stepped well forward, say about 18 ins. from the stem. If a sloop rig is preferred, the mast is stepped farther aft, to make more room for the head-sail or jib. The cat-rig is the best for a small boat. It is faster and is much more easily and quickly handled. In any case, where the hole is cut in the deck, a mast-block must be screwed firmly on the underside of the deck, and a second block with a hole cut in the center for the heel of the mast to set in, is screwed to the floor directly under the mast-hole in the deck.

The boat should be painted with three coats of good paint, and to avoid the difficulty of reaching the extreme parts of bow and stern after the decking is on, paint these places as the work progresses, not forgetting to paint the bottom underneath the keel, and the inside of the centerboard trunk. A single coat of thick paint will suffice. The outside, or the entire coaming may be finished "bright" if desired, in which case give it three or four coats of good spar varnish.

The mast may be rounded by planing and tapering a spruce or white pine or cedar stick, 3 ins. by 3 ins.; or a natural pole of the required diameter may be cut in the woods. Make it 3 ins. in diameter from heel to deck, then a uniform taper to the top which should be 2 ins. Square the heel to fit the mast step, making a loose fit, to allow for swelling. A round spar is not at all difficult to make. Simply plane off the four corners, then take these corners off to make it six-sided. Now plane these six corners off and a nearly round spar is secured. Scrape round with a steel cabinet scraper, and finish with sand-paper.

The boom should be about 2½ ins. in the center, tapering to 2 ins. at the foot (mast end) and about 1½ ins. at the other end. The gaff may be made 2 ins. in the center, tapering to 1¼ ins. at either end. Both boom and gaff should be made at least 6 ins. longer than the width of sail, to allow for stretching of the canvas. A goose-neck attachment may be used to attach the boom to the mast, or a patent sail hoist may be used for both boom and gaff. These are expensive, and the ordinary boom and gaff-jaws will answer. Jaws may be purchased with cleats and



These diagrams show the construction of several small parts of the boat

other fittings, or sawed out from oak or ash.

A light sail is needed, and this may be made at home on the family sewing machine, or sewed entirely by hand. Five-ounce unbleached cotton drill is heavy enough, and yard wide material may be used. The bights or laps are made by turning over a fold on each side, about 1 in. wide, and stitching along the two edges. Narrow laps about 6 or 8 ins. make a neater appearance and strengthen the sail. The laps must be made to run parallel with the leech, as shown in the sail plan, page 929. The corners of the sail should be re-enforced with a segment of canvas sewed on each side. About 1 foot above the boom, sew in a row of reef-points (⅛-inch cotton rope) so that 6 ins. may hang from either side. By tying these together around the boom, the sail is shortened or "reefed," as the nautical term expresses it. The sail may be bound with cotton rope, but a simple and strongly stitched hem will answer. At the leech make a 1-in. hem, so that a small rope may be run through to take up any slack as the sail stretches out. This prevents that bug-bear among sailors, a flapping leech, and makes the sail set flat and not bag.

The sail is attached to the mast by mast-hoops; either oak or metal hoops may be used. Seven or nine hoops will be needed, in the 3 or 3½-in. size. Grummet holes must be worked in the sail on the side marked hoist, and the sail secured to the hoops by seizing with a double strand of marline. To make the grummet holes, purchase a dozen or so of ½-inch galvanized iron grummet rings, cut a ½-inch hole and place a ring on either side of it, and sew over and over with waxed sail-twine—overcasting the ladies term it. Your mother or sister will show you how to do it. A row of grummets must also be worked in along the boom and the gaff to attach the sail to these spars, putting a grummet at each lap or bight.

To rig the boat, procure a mast band with two eyes, of the right size to slip down about 2 or 3 ins. from the top, where it should bind firmly. Drive the band on with the two eyes fore and aft, that is, in line with the boat. To the forward eye, splice or seize a length of 3/16-in. wire rope, which must be long enough to reach the stem where this end is secured by seizing to an eyebolt screwed into the oak stem. Instead, a strap fitting the stem may be used. This is the stay to support the mast.

To the rear eye in the mast-head band, seize a metal pulley-block (2-in. shell, for ¼-in. rope is correct size). This is for the peak halyards. A foot or so below this block, screw an eyebolt in the mast and fasten a similar pulley for the throat halyards. To the gaff, splice or fasten a bridle of wire rope and to it fasten the end of the peak halyard, either with a bridle clip or a bull's-eye, which is merely a wooden ring with a groove in the outside circumference in which the rope is spliced or seized.

On each side of the deck, opposite and about 6 ins. from the mast, screw a galvanized deck-pulley. This arrangement will lead the halyards aft to within reach of the helmsman, and also serve to support the mast.

At the bow, screw an open bow-chock 3-in. size, on each side of the stem on deck. A cleat is unnecessary on the forward deck, for the mooring line may be more securely fastened to the mast.

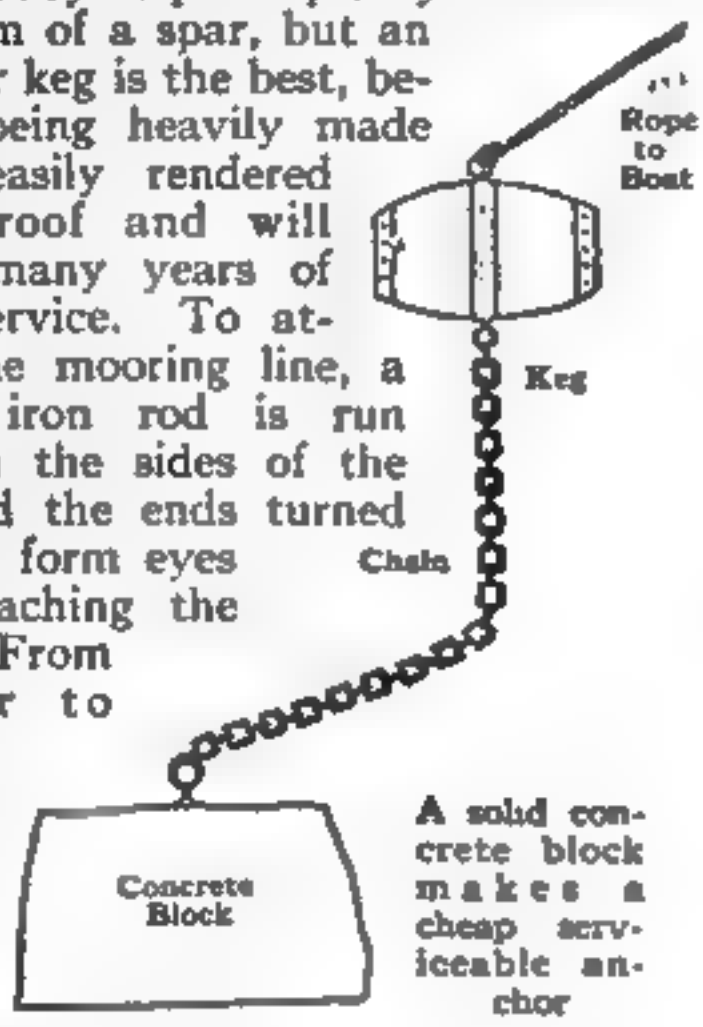
The main sheet may be rigged in several ways, but in a small sail like this no great purchase is required, and two single blocks will be sufficient. To avoid shifting each time when going about, however, a traveler may be screwed to the after deck. This is simply an iron rod about 18 ins. long, fitting with a sliding ring to which a pulley is seized. When going about on another tack, the sail shifts without attention. Cleats for belaying the sheet may be screwed to each side of the deck, but a cleat placed in the center of the rear seat or on the deck, will make it unnecessary to shift the rope every time one goes about.

A Cheap, Practical Mooring for Your Boat

While a 20-pound anchor is about the right size for our craft, most boatmen prefer to use a heavier mooring for the permanent anchorage, with a marking buoy or pick-up. One of the best moorings is easily and cheaply made of

concrete. For a small boat, an old dishpan makes a splendid form in which to cast our anchor. A good quality of Portland cement must be used, in the proportion of one of cement to two of gritty sand. Mix thoroughly and add a quantity of broken or any old iron bolts and other small bits of scrap iron you may happen to find. In the center of the form, embed a large eyebolt with a large washer firmly riveted to the end.

The buoy or pick-up may be made in the form of a spar, but an old beer keg is the best, because being heavily made it is easily rendered waterproof and will stand many years of hard service. To attach the mooring line, a heavy iron rod is run through the sides of the keg and the ends turned over to form eyes for attaching the cable. From anchor to buoy, chain is best but rope is all right if renewed each season.



A solid concrete block makes a cheap serviceable anchor

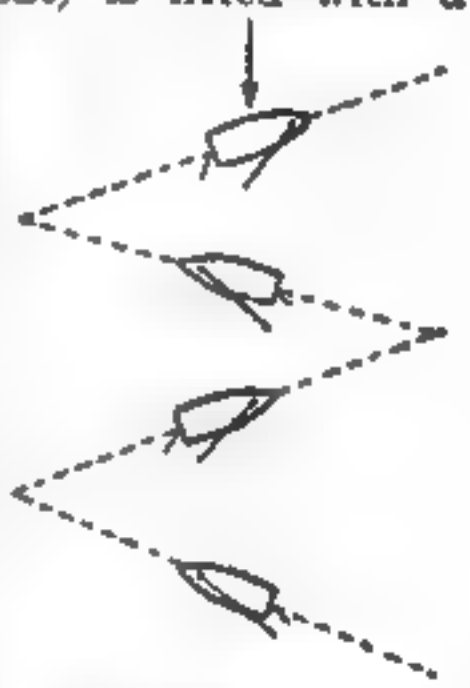
How to Sail Your Boat

The knack of handling sailing craft is quickly learned, but the many little practical wrinkles of seamanship are only to be picked up after considerable experience on the water. Sailing is not the dangerous sport many people imagine it to be, however, and if the boat is of good model and not over-rigged, practically all accidents may be placed at the door of carelessness and ignorance or a desire to appear smart and show off. Of course every boatman should know how to swim; one does not anticipate a capsize or collision, it is true, yet accidents occur now and then, and the ability to keep afloat is well worth acquiring—even if only for the greater confidence it gives.

As every boat possesses certain characteristics and little peculiarities, the handling of one craft differs somewhat from that of another, but the principles of handling are the same for all craft propelled by sails—from the four-masted schooner down to the little skiff we have just built. Hence, the owner should know his own craft—how much sail she can safely carry to get the best speed, and so on.

While a knowledge of the theory of sailing is not at all necessary to sail a boat, every skipper should have some idea of the effect of the wind on his craft. Now the wind pressure against the sails of our boat acts in two directions—it presses and drives the boat ahead, and also forces it sideways, to make it tip or "heel." The pushing force of the wind is of course encouraged in every possible way, by proper rigging and handling, while the heeling tendency is counteracted by making the boat sufficiently stable to resist the upsetting force. This is gained by building the craft of ample beam, by using a deep or heavy keel, or by ballasting the boat with lead, iron, rocks, sand-bags or other heavy weight placed on the bottom of the craft.

When a smooth-bottomed craft (like a common row-boat) is fitted with a sail, the side pressure is so marked that the boat will be forced sideways even faster than it is propelled ahead. This sliding or "making leeway" as sailors call it, must be eliminated so far as possible, and this is done by using a deep keel or—in the case of the boat we have made, by using a centerboard. When sailing close-hauled or beating against the wind, the centerboard is dropped, thus affording resistance to the side pressure. When sailing free, or directly before the wind, the board is raised, so that all the driving force of the wind may be gained to propel the craft forward.



By "tacking" a boat can proceed against the strongest wind

Owing to the fact that the wind pressure on the sail exerts a certain force on the bow of the boat, this "veering" is overcome by swinging the rudder at an angle. This balances the force of the sail. Every well-designed and properly rigged boat—whatever its size or number of sails—should have what sailors call a "weather helm;" that is, if the tiller is let go, the boat will fly up into the wind and come to a stop with the sails shaking. This is accomplished by using a properly proportioned head sail or jib, and in single sail or "cat-rigged" boats like the one we have made, by stepping the mast well forward toward the bow. A few boats carry a "lee helm," that is, if the tiller is let go the boat sags off to leeward, and if the rudder is not thrown across to prevent it, the sail will jib over and the boat swing around as on a pivot. A boat thus badly rigged and balanced, is a dangerous craft for anyone to handle; it is a tricky boat. Furthermore, a boat so balanced is slower under sail, because the rudder must be swung across at a considerable angle in order to keep it headed up to the wind, and this drag of the rudder greatly retards the speed.

Some boats can sail closer to the wind than others and the single sail or cat-rigged type will point higher to windward than a sloop-rigged craft which carries a jib. No boat can sail directly against the wind; therefore, when sailing up-wind we must travel at an angle—which diagonal course is called "tacking." Suppose we are sailing close-hauled—beating to windward, the wind blowing in the direction indicated by the arrow, page 931. As we cannot sail directly against the wind, we must "tack" or sail a certain distance close-hauled with the wind on one side, and then go about and sail close-hauled with the wind on the other side. Thus we proceed to windward in a series of zig-zag courses

In the diagram just referred to, the wind is "dead ahead" and the tacks are equal. If the wind is a point or two off, as shown in the next diagram, one tack will be longer than the other, as shown in the dotted lines. This sailors call "making a short leg and a long leg."

Tacking against the wind or "beating to windward" as most skippers call it, naturally requires much practical experience before one can get the best speed out of a boat. Some boats will sail closer than others but any well-designed and properly rigged craft should be able to point up within 45 degrees of the wind.

When sailing as close-hauled as possible the sail must be trimmed rather flat. It is, of course, possible to pull in the sail too much; this must be avoided for if trimmed too flat, the speed of the boat is much retarded and the side drift or leeway becomes more marked. In trimming the main sheet, pull it very flat, then ease it off until the edge of the sail along the hoist or mast wrinkles and flutters. The old hand always makes use of this fluttering, which indicates one is sailing "full and bye" or as close to the wind as possible without sacrificing an iota of speed.

In handling the boat, a good skipper will endeavor to "coax" his craft closer to the wind, "crawling to windward" as the sailor calls it. This is done a thousand and one times during a day's sail, by heading the boat close and then easing it off, with the sail just a-flutter.

When going about on another tack the boat is eased off a trifle, and the rudder thrown across, slowly and steadily. If the rudder is worked too quickly it checks the speed and may even put the boat in "stays"—so that it simply drifts sternwards, and necessitates swinging the bow around with an oar. When sailing with companions, going about is generally preceded by calling out "hard-a-lee," which warning enables passengers to duck the boom as it swings over, and to shift to the windward side if needed

The approximate trim of the sail with the wind at the several points of the compass, is shown on page 933. No. 1 shows the sheet trimmed flat for sailing close-hauled, No. 2 with bow wind, No. 3 wind a-beam, No. 4, wind abaft the beam, No. 5 wind on the quarter, and No. 6 with wind dead astern.

In small sailing craft, the boat is commonly ballasted or trimmed by shifting the weight of the skipper and one or two companions, but the boat

may be ballasted if desired. Perhaps the best way to do this is to fill a couple of canvas bags with sand or fine gravel, and place them on either side of the centerboard trunk. A cleat tacked along the floor will prevent the bags from shifting. Ten or twelve-ounce canvas bags re-enforced by sewing a length of 3/16-in. rope around the seams will be suitable. A rope strap-handle will make it easier to handle the bags, which should weigh about forty pounds each.

If the wind is not "dead ahead" the "tacking" must be irregular

In ballasting, the boat must be trimmed to ride on an even keel, or with just a trifle more weight aft of midship. If sandbags or other weights are used, ballast to an even keel, and your weight aft will trim the boat correctly. Too much weight forward makes a boat difficult to steer, and too much ballast aft causes the stern to drag too much water.

The skipper of any boat—be it large or small, should keep his "weather eye" open at all times. When sailing in a river or landlocked lake or bay, one must be on the watch for puffs, and head up into the wind or ease off the sheet a few inches. Moreover, the main sheet should not be made fast, but held in the hand, so that the rope may be cast off to run free at a moment's notice. In a brisk breeze, a half-turn around the cleat will take all strain from the hands, but allows the rope to render free at will.

When running straight before the wind, every boat will swing more or less from side to side, and this "yawing" is counteracted by swinging the rudder slightly in the opposite direction as the bow swings. A little sailing experience will show how the trick is done, for the good sailor can tell the behavior of a craft by the "feel" of his hand on the tiller.

When going about or changing the course, the novice should always come up into the wind, rather than pay off and jib the boom over. The experienced skipper can jib in even a heavy wind by easing off the sheet as the boat pays off and the boom swings over, and quickly pulling the sheet as the craft swings on the other tack.

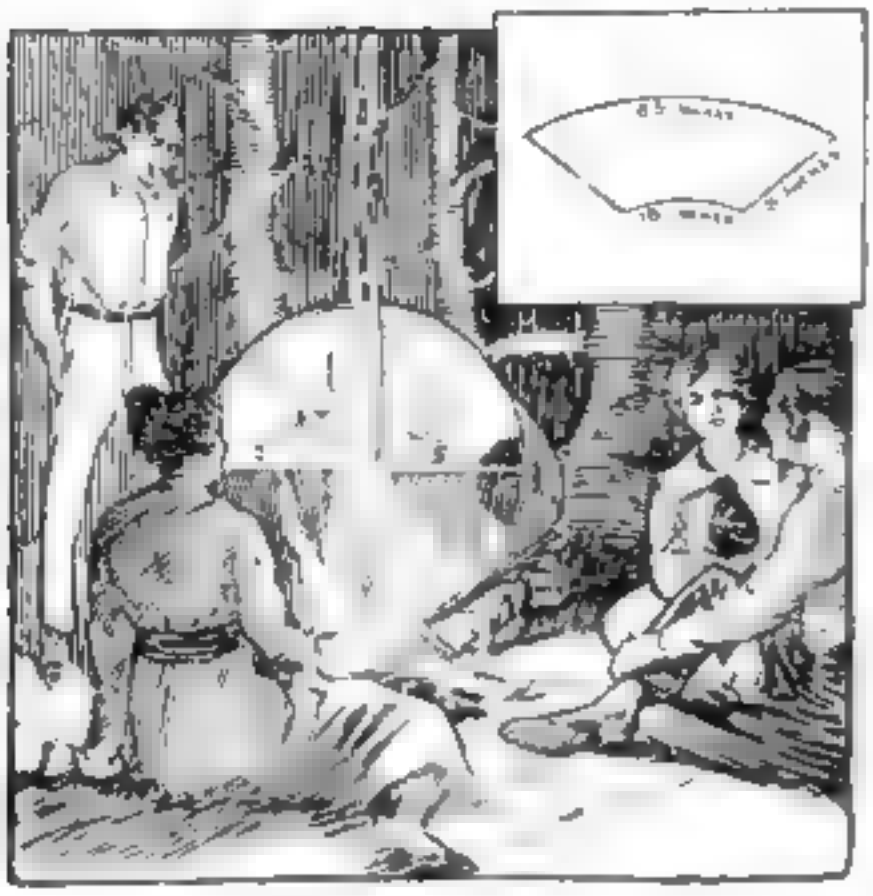
It is well to keep in mind this rule of the road at sea; that a boat on the starboard tack has the "right of way" over a craft on the port tack. By starboard tack is meant the wind blowing from the right or starboard side (sail to left or port) and vice versa when on the port tack.

When sailing past the lee of a vessel at anchor, or an island, keep your weather eye open. Your boat is certain to be becalmed or "blanketed" while passing, and as she draws clear of the object, the full force of the wind will strike your sail. Remember this and avoid a possible capsize. It is foolhardy to attempt to sail close to steamers and other large craft, for the sake of riding the swells. Keep away from them.

Sailing a boat in rough water demands judgment, especially when the wind and sea are a-beam. This is the most dangerous point of sailing, and calls for a cautious hand on the tiller. If the wind is strong and fresh, it is the wisdom of a sailor to reef and shorten the sail, rather than to stagger along under the whole spread. There is an old maxim which runs something like this—"A sailor shortens sail in time, but the landlubber cracks on sail until all is blue." Keep this in mind and avoid taking chances.

In rough-water sailing, with the boat heeled over to some fifteen degrees, a heavy roller may even capsize the boat. Guard against this, and when you note a particulary big wave coming, put up the helm a trifle, so that the wave may be taken on the bluff of the bow or abaft the beam. This use of the weather helm is one of the essentials in seamanship. Should a big wave seem

Diagram showing the trim of the sail with the wind at different points of the compass



All sorts of vegetables and meats can be baked in this camp oven without burning

about to come aboard over the bow, luff quickly into it and meet the wave bow on.

When running before a strong wind and heavy sea—"scudding" as the sailor knows it—the man at the tiller must be on the alert to keep his craft from broaching to, that is from flying up in the wind, on the one hand, and being "brought by the lee" on the other, which means running off so that the wind is on the other quarter.

The boom should be well topped up to keep it high above the water. As most small craft are not often rigged with a topping lift, the sail should be hoisted well up on the mast to afford more clearance for the boom above the water.

Should you happen to be caught out in a gale or squall, it may be possible to run to port under bare poles, or ride out the gale. Even a small boat will weather a heavy blow by rigging up a sea anchor. Of course a regular sea anchor is best, but a fairly good substitute may be fashioned by tying together a raft made of oars, boathook, seats, sails, cushions, etc., and let it drag from the bow, paying out some fifty feet of rope.

No sport is more exhilarating than sailing, and the fun is greatly enhanced if one can sail a boat which he has himself constructed.

A Camper's Dutch Oven

WHEN you go camping in the summer, either for a short or prolonged outing, the old-fashioned Dutch oven, which at one time was very commonly used, cannot be excelled as a cooking arrangement. It is a sort of fireless cooker, which can be built and set up anywhere by means of a few bricks or stones. It will cook meat, biscuit, bread, potatoes or anything else. The beauty of it is that it cooks by indirect heat or by reflection.

It is constructed of any kind of bright tin. To make a large one with an opening of about two feet, take a piece of bright sheet tin about 6 ft. long, and 3 or 4 ft. wide. Lay this out, and cut in the shape shown. Then roll it up, and fasten the edges by riveting. Cut a circular piece of tin to fit the back. Then directly through the center fit a thin piece of sheet iron from the open front to the apex. This is to hold the bread, biscuits and other articles. A smaller size may have an opening of about 21 ins.

This funnel-shaped piece of tin is set up on the ground, with bricks or stones supporting it on either side directly in front of your camp fire of blazing wood. The food is cooked entirely by reflection. The heat from the fire is reflected from the bright tin sides to the food. In a short time the heat inside the funnel is sufficient to cook a steak or fry a fish. Nothing will burn, for the heat is not direct, and there will be no cinders or ashes in the food.

The heat can be regulated by the distance from the fire, but the oven should not be placed close enough for the smoke and cinders to enter the funnel. The articles of food can be placed in the oven, and the open fire built. All that is required then is an occasional replenishing of the fuel. The Dutch used this oven in the house by placing it in front of the open grate fire. It can be used to good purpose in this way in the winter.

This camp oven is so cheap and so easily constructed, that it can be discarded when the bright surface of the tin has worn off, and a new one made. An oven of this sort affords a reliable and simple means of cooking outdoors.

Experimental Electricity

Practical Hints for the Amateur

Wireless Communication

Sharpness of Tuning in Radio

By John Vincent

THE effect of increased resistance in a freely oscillating circuit was described in the May article of this series. It was pointed out that the more rapid loss of energy, brought about by the presence of this added resistance, reduced the number of current oscillations in the circuit. It was also indicated that when the persistence of the circuit was thus reduced (as its damping or decrement increased), the system became less sharply tuned.

Fig. 1. A simple circuit

Just what is meant by the "sharpness of tuning?" Before this can be answered, it is necessary to look more closely at the effects of tuning itself. This phenomenon of resonance is, perhaps, made of more use than any other in the science of radio telegraphy; and yet it is often grossly misunderstood, even by skilled operators and experimenters.

Mechanical illustrations of tuning, drawn from the art of music, have been described in book after book; yet there seems to exist some difficulty in carrying over, into the purely electrical cases, the physical facts which these analogies should teach. Suppose that one disregards, for the moment, the sympathetic tuning forks and the tuned strings (both of which vibrate, though only one is plucked), and that one considers a simple electrical circuit having in series an inductance, a capacity, a resistance, a current indicator and a source of high-frequency sustained voltage. Such a circuit is that shown in Fig. 1. In the February article the effect of altering the circuit impedance by changing its inductance and capacity was described; when the values of the coil L and condenser C just neutralized, for the frequency generated by the alternator E, resonance was secured and the current indicated by I became a maximum.

The same circuit may now be studied with the alternator at rest. If a charge of electricity is placed upon the condenser and allowed to discharge freely through the circuit, there will be set up a feebly-damped alternating current of the character indicated by Fig. 2; this is on the assumption that the resistance R has a small value, as is usual in practice. The frequency of this free

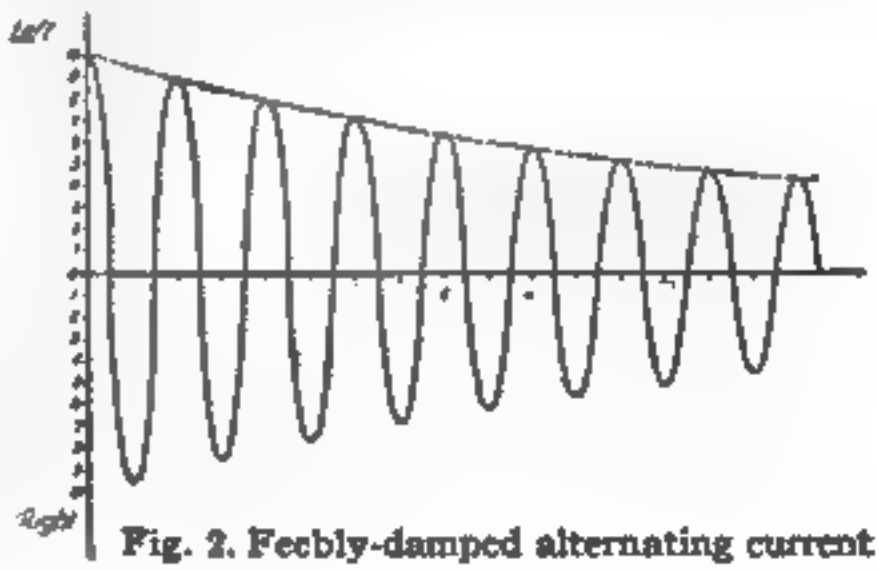


Fig. 2. Feebly-damped alternating current

oscillation may be determined by wavemeter measurement, or may be computed according to the rule given in the March article. Speaking generally, what happens is that the dielectric of the

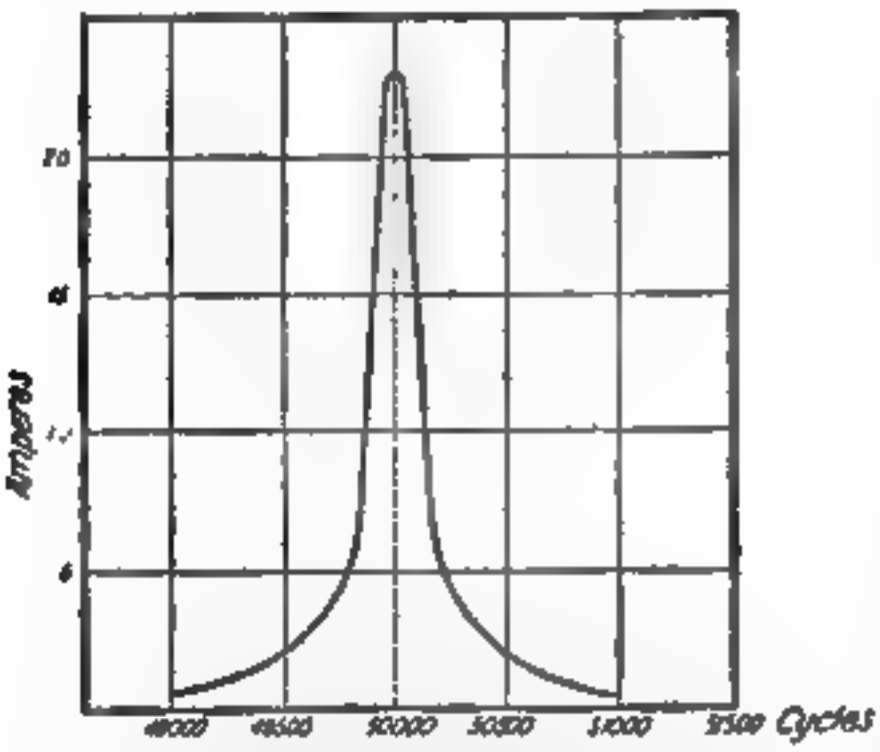


Fig. 3. Curve showing the rise and fall of current by varying the frequency

condenser is electrically strained in one direction when the charging voltage (or pressure) is applied to it; as soon as the pressure is relieved, the strain reacts and its energy produces a current through the circuit (Fig. 1) from the positive plate of the condenser toward the negative side. In passing through the inductance the current sets up a strong magnetic field, which expands and stretches away from the coil as the current through it grows larger. Since there was only a definite amount of electrical energy forced into the condenser by the original charging voltage, there is a limit to the amount of current which can be produced by the discharge; as soon as this limit is reached the magnetic field around the coil L begins to contract, and adds its energy to the current flowing toward the negative side of the condenser. By this time the condenser is fully discharged, that is, the two plates are at the same potential. But the magnetic field is still collapsing on the coil, and therefore, current is forced to continue flowing in the same direction as before; this results in a piling up of potentials on the "negative" plate of the condenser and a reduction of electrical pressure on the plate which was "positive." In other words, the reaction of the magnetic field has caused the condenser to assume a new charge, of polarity opposite to that which it had originally. The pressure of this inverted charge increases until the energy of the magnetic field is exhausted; then the condenser discharges once more, but in the opposite direction. A current flows back through the inductance, and an expanding field is set up, just as before, except that the polarity is reversed. The contraction of this second magnetic field forces a new charge upon the condenser, and this time the polarity is the same as of that which began the oscillation. Since a limited amount of energy is set free in the circuit, and since some of this energy is used in heating the wires (because of their resistance) each successive charge and each successive current is smaller than that which preceded it, and the free oscillation is damped, as shown in Fig. 2. The greater the resistance of the circuit the greater the proportion of the original energy, which is lost in heat at each oscillation, and the sooner the current is damped down to a very small value.

What has this internal action of a resonating circuit got to do with its resonant condition, or its tuning (which is much the same thing)? In a word, everything. Why? Because "tuning"

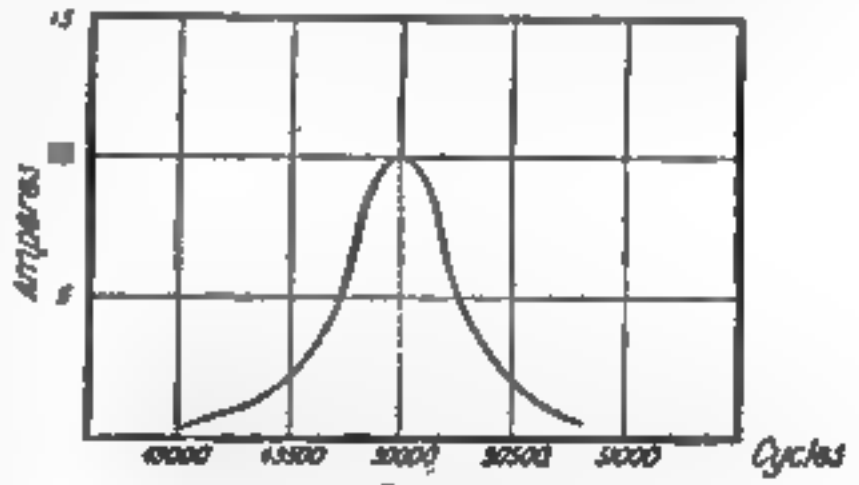


Fig. 4. Curve showing changes in current by altering the resistance

is little more than taking advantage of this self-swinging power of a circuit so that energy may be added to it at just the right time to give its oscillations the largest amplitudes possible. In adding small amounts of energy to an oscillating electrical system, the addition must be made by the application to it of corresponding magnetic or electric forces. That is, small charges must be put upon

the condenser one at a time, or small additional currents must be introduced by way of the inductive portions of the circuit. These charges must be applied at the instant that the natural (or self-oscillating) charge of the condenser is of their polarity, for otherwise no advantage of increased charge would be had; similarly, the increments (or additions) of current must be made when the natural current is flowing in the proper direction, for, if not, there would be an opposition to the normal current in the circuit and no increase would be secured. This is as certain as the fact that, in order to make a swing go higher and higher, it must be pushed when it is moving or about to move in the same direction as the applied force; and it is true for the same reason.

Let us now assume that the alternator *E* in Fig. 1 is capable of delivering 1 kilowatt of electrical power at 50,000 cycles per second, but can run safely at speeds as high as that giving 100,000 cycles. Let the inductance and capacity be of such values that the natural frequency of the circuit is 50,000 cycles per second (corresponding to a wave-length of 6,000 meters), and consider that the total resistance is two ohms. If the alternator is started from rest and gradually speeded up, it will

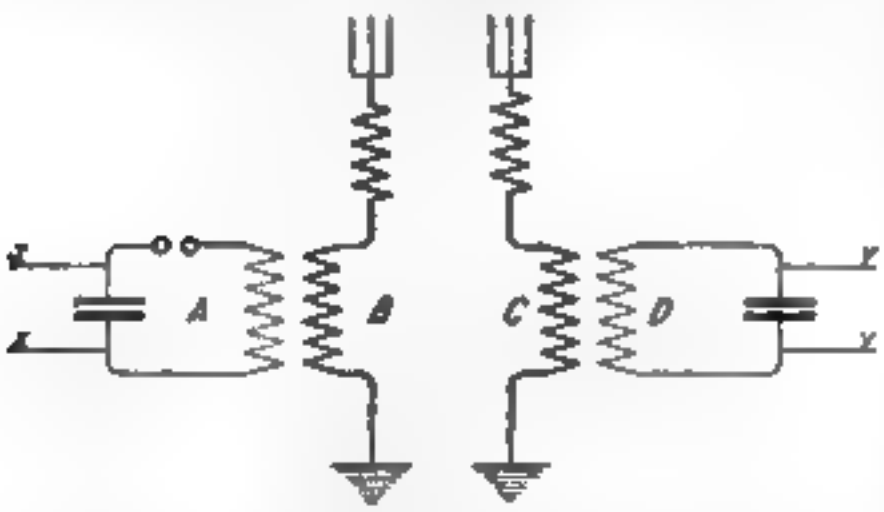


Fig. 6. A closed and an open circuit (A and B) are used to radiate waves to a receiving antenna, C

produce pulses of alternating voltage at gradually increasing frequencies. These voltage impulses will charge the condenser *C* first in one direction and then in the other; but very little current will flow, because there is no tendency for these lower-frequency voltages to co-operate by resonance. As the frequency comes close to 50,000 per second, however, the current will commence to rise, and at 50,000 cycles it will reach a maximum of about 23 amperes. At this frequency the small voltage additions produced by each cycle of the alternator are impressed upon the condenser exactly in step with the natural oscillation voltages, and the greatest possible oscillation current results. When the frequency is increased beyond 50,000 cycles, the resonant value of the circuit, the circuit begins to fall off very rapidly. If one measures the current at each of a set of frequencies near the tuned point, the result may be plotted in the form of a curve like that of Fig. 3, where the intersection over each frequency shows the amount of current indicated by *I* when the alternator is run at the corresponding speed. It should be noted that the rise and fall are extremely sudden.

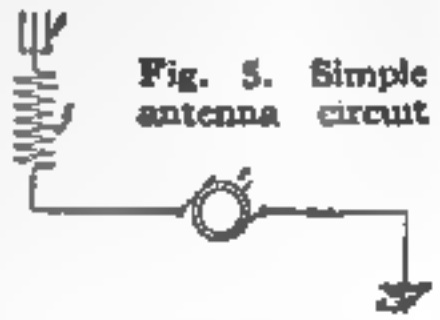


Fig. 5. Simple antenna circuit

Suppose now that this same experiment be repeated with all conditions remaining the same, except that the total resistance of the circuit is set at 10 ohms. As the speed of the alternator is increased it is noted that the current begins to rise in the neighborhood of 50,000 cycles, as before, and to fall after that speed is passed; the interesting features are, however, that the maximum current is now only 10 amperes, and that the rise and fall near the resonant point are not nearly so sudden as before. By taking a series of careful measurements and plotting them out in curve form, a diagram like that of Fig. 4 may be produced. The slope of the sides of this curve is considerably less than that of Fig. 3; the effects of adding resistance have evidently been to decrease the current at resonance, and to make the circuit less sharply dependent upon applied frequency. We know that this means the tuning of the circuit has become less sharp; we know also, that the adding of resistance has increased the damping of the free oscillations in the circuit. These two results are closely related.

Next, the application of these experiments to a modern radio telegraph

transmitter may be considered. If the condenser, inductance and resistance of Fig. 1 are replaced by the antenna circuit of Fig. 5, it is easy to see that the constants of the two circuits may be made substantially the same. If the total antenna resistance is 2 ohms, the resonance curve of Fig. 3 will indicate the variation of antenna current with frequency; while, if the resistance is 10 ohms, Fig. 4 will be correct. In the former case over twice the current will flow between antenna and ground than in the latter; if the antennas are of the same height, that having the lower resistance will radiate energy over four times as effectively. However, in order to keep the current at its maximum value in the low resistance antenna, it is necessary to regulate the frequency of the alternator much more closely than is needed in the second case. Thus, in an alternator sender, low resistance and consequent high natural persistence may be a practical disadvantage; it is sometimes necessary to compromise between highest electrical efficiency and greatest operating convenience.

In all the above cases the source of radio-frequency power is an alternator, and the currents and waves involved are of the continuous or sustained type. In such circuits the damping does not effect the sharpness of radiated waves, but only their amplitude and the ease with which the greatest intensity may be secured and maintained. In spark-discharge circuits, which depend upon their natural constants to determine not only the amplitude and frequency, but also the decrement of the oscillations within them, the circuit damping becomes of the greatest importance. The details of this branch of the subject are so involved that it is not possible to treat them fully in a series of elementary articles such as these; only certain fundamental facts can be presented.

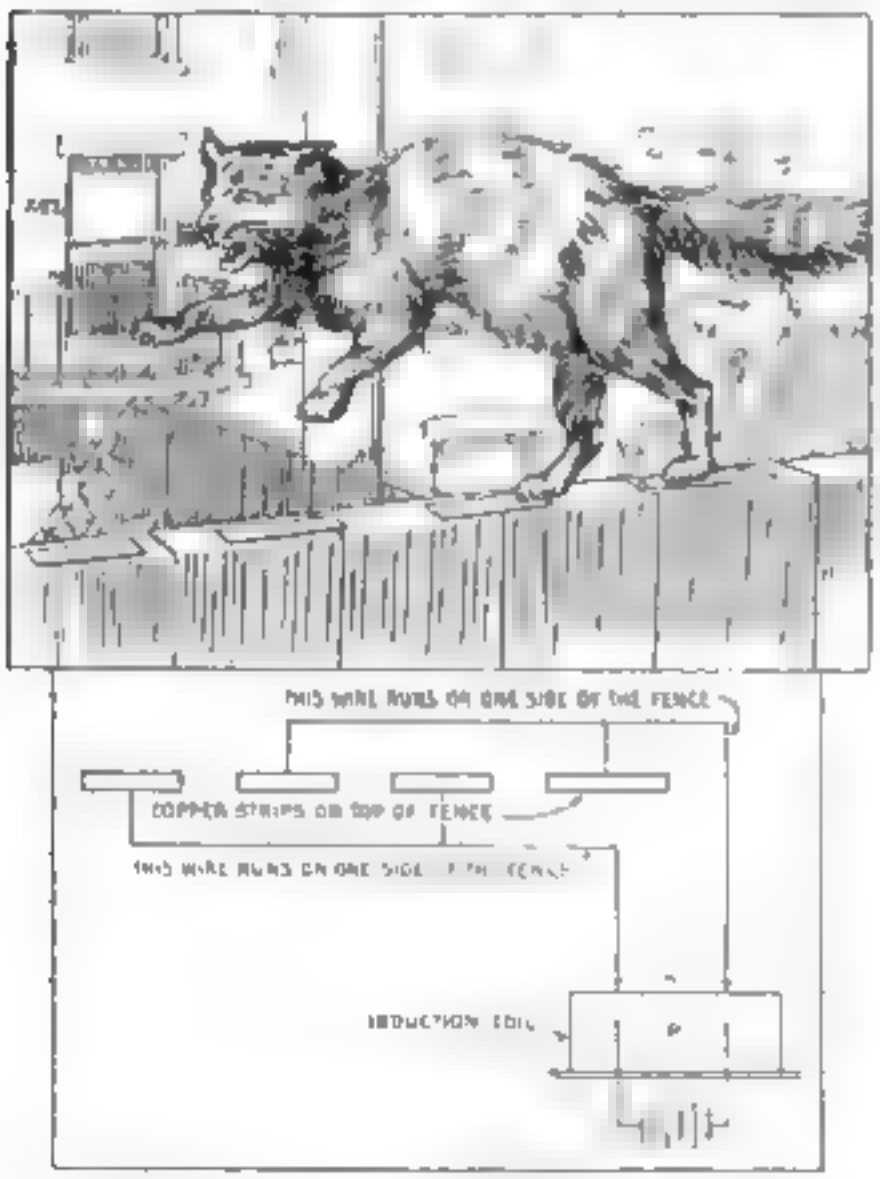
From the experiments in connection with the circuits of Figs. 1 and 5, it is evident that the maximum transfer of energy from the alternator to the circuit in which it is connected can occur only when there is minimum impedance (or at the tuned point), and maximum persistence (which corresponds to the condition of least effective resistance). This broad principle is applicable to all cases of resonant transfer of energy; the largest exchange occurs when the exciting oscillations and the excited circuit are of the same frequency and of the greatest persistence. It makes little difference whether the energy is transferred magnetically, as in an inductive coupler, or by electromagnetic waves extending over long distances; agreement of frequency and persistence are essential. It is well to note that if the exciting oscillation is damped there is no gain secured by increasing the persistence of the excited circuit beyond a certain point; reduction of resistance to the amount which gives this best condition is helpful, however.

That this general principle applies to radio receivers as well as to transmitters may be seen by consideration of Fig. 6. In this diagram, *A* and *B* represent respectively the closed and open circuits of a spark-type transmitter, and *C* and *D* mark the antenna and secondary circuits of a receiver located some distance from *A* and *B*. If the condenser of *A* is charged and allowed to discharge across the gap, electrical oscillations will be set up in the closed circuit. These will have their frequency determined by the effective values of the capacity and inductance of the circuit, and their damping will depend upon the inductance, capacity and effective resistance. If the circuit *B* has the proper natural frequency, it will be excited violently by the voltages impressed across the inductive coupling, and a comparatively large current will be set up in it; this antenna current will have the frequency of the two circuits *A* and *B*, and a damping dependent mainly upon the effective resistance of the aerial circuit. Waves of this same frequency, and of the damping of *B*, will be radiated and will pass over the earth's surface to the receiving antenna *C*. If *C* has the correct tuned frequency, currents will be set up in it; if the effective resistance is of the proper value, these currents will have the largest amplitude. In the same way as at the transmitter, maximum transfer to the circuit *D* will take place if this final circuit is not only tuned, but is also of the proper persistence.

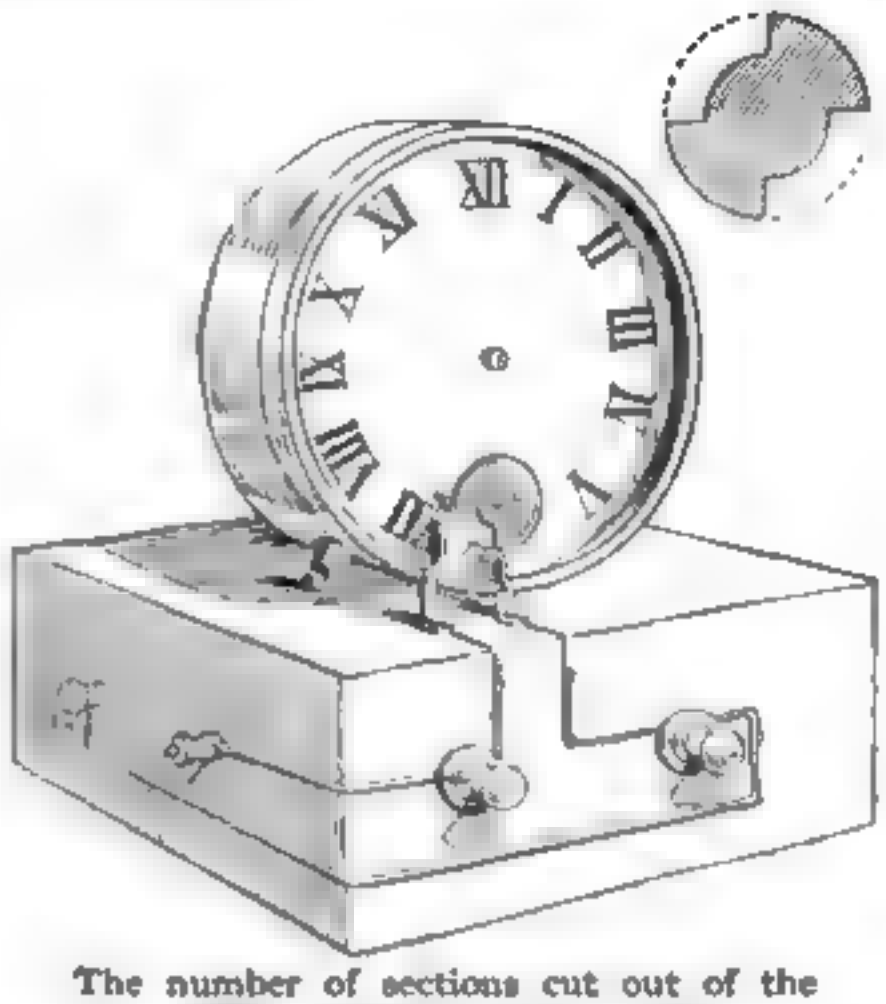
For Those Midnight Serenaders

SOME people live in neighborhoods that are very popular with cats. The fence is the back-yard band stand, where cats of all sizes and vocal abilities assemble and give voice to their woes just as one is preparing to go to sleep. After ineffectively following the accepted plan of hurling shoes, hair-brushes and other missiles at the disturbers, one sufferer decided to solve the problem with the aid of electricity. The plan has worked admirably.

The fence was made of boards separated about one quarter of an inch. Along the tops of these boards he nailed short strips of brass and connected them alternately to the terminals of a small induction coil which had been discarded from an automobile. When the midnight serenaders trod upon these alternate strips, their musical inspiration departed completely, and they themselves followed it swiftly, but quietly. Of course it was necessary to have the coil turned on all night, although the inventor plans to install a clock-work regulator made from an old alarm clock, so that the coil will have to work only during those hours when the night is most hideous. He expects that, in time, the cats will be wise enough to pass the word along to leave his back fence alone.



Would that we could apply this principle to the back-yard band and also to the organ grinder!



The number of sections cut out of the brass disk determines the number of flashes produced

Making a Simple but Efficient Flasher

A FLASHER for low voltage lamps can be made in the following manner: Remove the hands, including the second hand, and the glass from an old clock. Make a small brass disk (this can be done on a lathe), with a hole in the center just large enough to fit snugly on the axle of the second hand. Divide the disk into four parts, and describe a concentric circle, as shown in the diagram. File out two pieces along these lines, as indicated in the diagram. After replacing the second hand and the disk, fasten the clock to a board.

Two brushes can be made from an old clock-spring, after taking the temper out by heating. Screw them to the board in such a position that they touch the wheel lightly. This arrangement and also the connections with lamps and battery are shown in the diagram.

If more flashes are wanted, a greater number of sections can be cut out of the disk. Many different combinations can be produced. Instead of ordinary white bulbs, colored ones can be used, adding greatly to the effect.—JOSEPH KRAUS, JR.

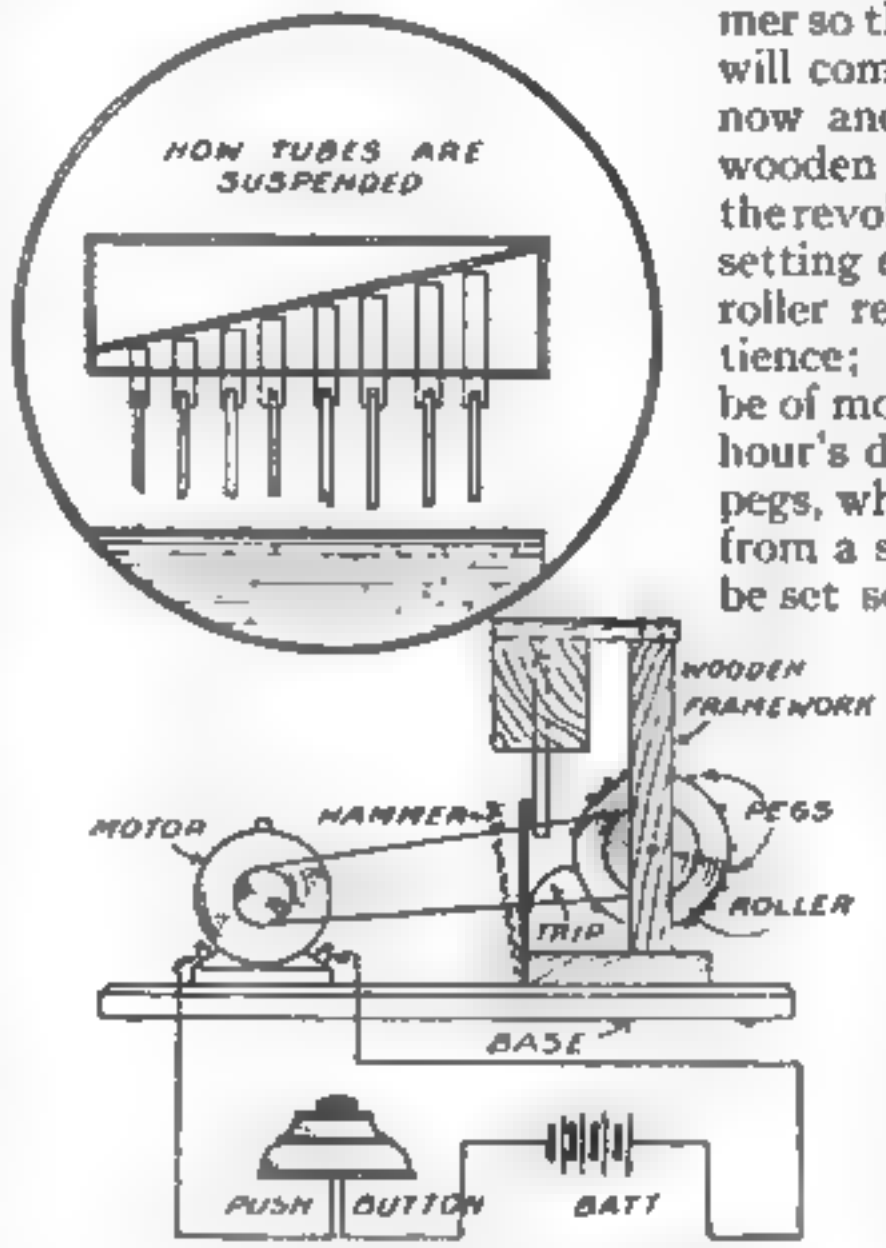
A Musical Electric Door-Bell

AN unusual door-bell, differing from the noisy regular electric bell, is here described. This apparatus may look unpractical and clumsy, but it can be covered up in a neat wooden case, if desired. Procure a small instrument commonly known as the "tubaphone." A tubaphone consists of a wooden rack on which are mounted several pieces of brass tubing cut into different lengths, and properly tuned to give forth the various notes of the scale, when set in vibration. Such instruments are usually sold at fifty cents, the price depending upon the size, etc. Several strips of pine about 2 ins. wide, and 7/8 in. thick are procured to be used in the framework. It is simple to make, and is readily understood by examining the diagram.

The tubes are suspended, as shown, on rings or rubber bands. The distance between the tubes should be at least one inch; the first and last tubes must also be about one inch from the edge of the framework, for placing a support on each side.

The base may be of any size desired, but these dimensions can only be determined by calculation, and upon the number of brass tubes used, etc. A roller should be turned out from a piece of pine, long enough, of course, to be within the range of every hammer striking the brass tubes. A shafting attachment on the roller is also to be provided for.

Lastly, the hammers are made of sheet brass, having a length that will reach from the base of the apparatus, to a point slightly above the bottom of the suspended tubes. A hole is drilled in the bottom end of each strip, which is firmly fastened to the base by a round-headed wooden screw. The hole drilled in the upper end of the strip serves to admit a screw holding a wooden hammer-head. A small strip of felt is glued to each striking side of the block. These proceedings, as described, are carried out for the other strips, hammers, etc., along the apparatus. Another piece of brass is fastened to each of the long hammers to act as a trip. It is riveted to the hammer so that its upper end will come in touch every now and then with the wooden pegs, fastened on the revolving-roller. The setting of the pegs in the roller requires some patience; one mistake will be of more value than an hour's description. The pegs, which are obtained from a shoemaker, must be set so that the music will sound correct, care being taken that the higher tubes vibrate in sympathy with the lower notes. With an ordinary motor and push-button, with the connections depicted, the arrangement will be found complete.



The mere pushing of a button at the door causes this apparatus to play a tune

As soon as the button is pressed, the motor will revolve, and, being shafted on to the roller, will rotate it. The pegs will actuate the hammers, and the hammers will in turn vibrate the brass tubes, producing the musical strains, which show that someone is at the door. Such melodies as "Home Sweet Home," may be made and if the folks tire of the same tunes, several rollers may be on hand and changed as often as desired.

Antenna Wire Strength

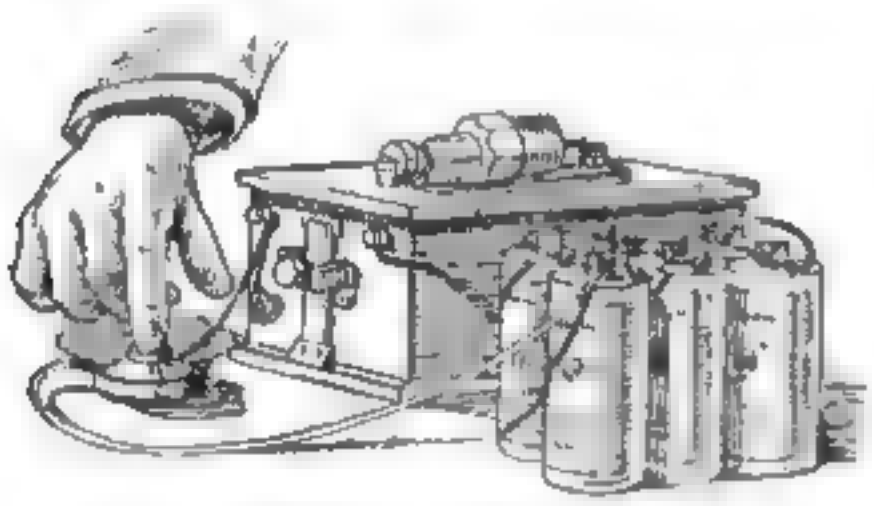
PHOSPHOR bronze antenna wire is practically as strong, for the same cross-section, as the best iron. This is nearly twice the strength of copper and over four times that of aluminum.

An Efficient Spark-Plug Tester

IT is a very simple matter to test a spark-plug by the use of a small spark-coil as shown in the accompanying diagram. By placing the plug to be tested across the terminals of the coil and pushing the button, if the plug is in working order a very bright spark will jump across the gap. If the plug is "dead" the circuit will either remain open or else the current will flow without making any spark.

This method of testing is of particular value in detecting short-circuits. For instance, it frequently happens that the insulation of the plug breaks down at a point above the gap, in which case the explosion caused by a plug in this condition will be weak and result in loss of power in the engine. Such a short-circuit can be detected at once as the spark will jump across at whatever point the insulation is weakest.

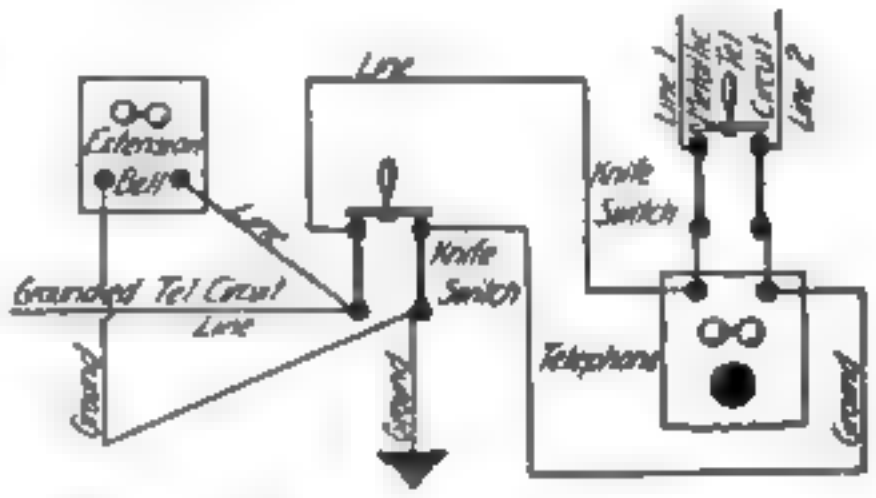
The trouble and annoyance of testing spark-plugs by running the engine may be obviated by the use of this simple method of testing, easily arranged by any experimenter.—H. A. HOOPER.



This apparatus is especially valuable for testing short-circuits

Connecting Dissimilar Telephone Lines

THE diagram shows an arrangement for connecting a grounded and a metallic telephone circuit so that the same telephone can be used on either or both lines. When the switch is left open on the grounded telephone circuit, the extension bells remain grounded and rings are received. When this switch is closed and the switch on the metallic line is opened, the telephone is cut in on the grounded circuit and conversation can be carried on over that line. If both switches are left closed, rings are received simultaneously on both sets of bells, and conversation is possible over the combined circuits not only from the telephone in the diagram but between any other stations on the two circuits. Thus, either circuit can be used independently of the other, or at this station the other telephones can be switched back and forth if that service is desirable. This will be found advantageous on many rural lines connecting with magneto switchboard exchanges. It will also be of use on private party lines.—J. G. ALLSHOUSE.



The same telephone can be used on a grounded and a metallic telephone circuit with this arrangement

Connecting Wires With Tinfoil

PERHAPS a number of readers experience trouble in making a good wire connection when solder is not at hand. They will find the following method very efficient, especially with aluminum wire.

Scrape about 8 ins. of the wire to be connected. See that all the dirt, corrosion, and grease are thoroughly scraped off. With the aid of pliers, twist the wires together very tightly. A piece of tinfoil, about an inch wide, should be lapped over the connection twist. The tinfoil should be lapped together as tightly as possible, without tearing and then pressed with the fingers. After this proceeding one or more layers of tape are stretched over the tinfoil, so that corrosion, rain, etc., will not affect the connection. The tape is pulled very tightly, to insure a good connection of the tinfoil with the wire. It is well to paint it with asphaltum.

It should, of course, be understood, that this expedient should be resorted to only when solder is not at hand.

Money Prizes for Radio Articles

We want you to tell our readers how you have overcome your wireless troubles. Every radio operator, amateur or professional, has encountered difficulties in building or using his apparatus. Many different people are bothered by the very same problems day after day. It will help you to learn how others worked to get successful results, and it will help others to learn how you succeeded.

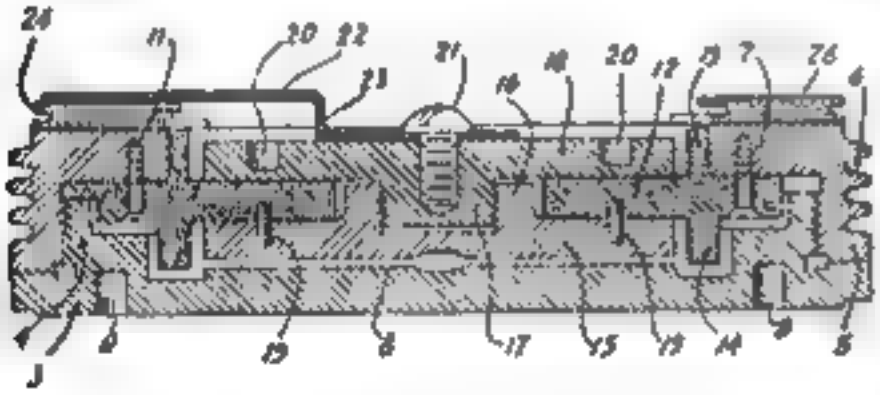
For the two best articles describing how you overcame troubles in building, operating, adjusting or repairing any radio instrument or group of instruments, we offer first and second prizes of $25.00 *and* $15.00 *respectively. The prizes will be awarded to the two writers whose articles, in the opinion of the Editors, will prove most helpful to the readers of the magazine. The Judges of the Contest, who will be the Editors of the* POPULAR SCIENCE MONTHLY, *will select the prize-winning manuscripts from those which conform with the following conditions:*

CONDITIONS OF PRIZE CONTEST

1. *Manuscripts must be typewritten, and on one side of the paper only.*
2. *Illustrations must be on sheets separate from the manuscripts.*
3. *Articles must be addressed to the Radio Prize Contest,* POPULAR SCIENCE MONTHLY, 239 *Fourth Avenue, New York, and must reach that address before June* 15, 1916, *in order to be considered.*
4. *Manuscripts which do not win prizes may be purchased for publication, at the option of the Editors and at the usual liberal rates.*
5. *The decision of the Judges, which will be announced in the August,* 1916, *issue, is to be final.*
6. *Each manuscript must be accompanied by a letter containing criticisms and suggestions as to the wireless section of the* POPULAR SCIENCE MONTHLY. *The merit of these letters will not be considered in awarding the prizes, but their suggestions will be taken as indications of what types of articles are of the most value to our readers.*
7. *If contestants wish to have their manuscripts returned, they should send postage for that purpose.*
8. *Articles should not exceed* 2,000 *words in length. If you cannot present your information in an article of that length, write several articles, each on a different phase of the subject, and each independent.*

Unit Type of Plate Gap

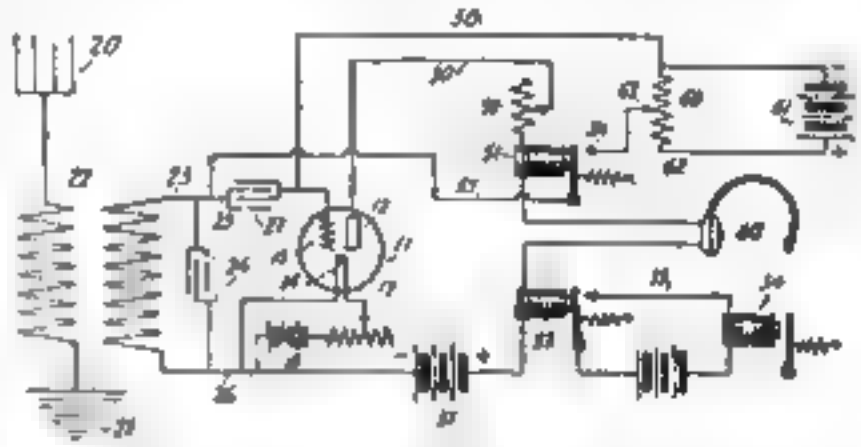
A NEW type of unit quenched spark-gap is shown in the illustration, which is taken from 1915 patent No. 1,163,568 issued to F. G. Simpson. This gap is of the plate type, but differs from the ordinary plate quenched gap in that damaged sections may be removed without deranging any of the rest of the apparatus. Each unit contains a pair of sparking surfaces, one of which is formed by the upper side of plate 3 and the other by the lower face of 15. These opposing surfaces are machined to be perfectly plane and parallel, and are mounted by the use of the clamping members 5 and 18. The two plates are kept apart mechanically and electrically by the insulating piece 12. The details of mechanical construction are clear from the diagram; it should be noted that the spacing of the gap depends upon the distance that 3 is screwed into 5, and not directly upon the thickness of the insulating separator. Stops 24 and 26 are provided to keep air spaces between adjacent pairs of plates, and with the flanges 6 in the outer metal piece, aid in keeping the gap cool. The required number of sections, such as illustrated, are grouped to form a complete gap, and connection from the inner plate of one unit to the outer of the next is made through the strip 22.



The mechanical construction of a quenched gap unit of the plate type

Preventing the Audion from Choking

MANY operators have noticed when they are using the audion detector that there is a tendency for the grid to charge too rapidly and "paralyze" the bulb. In times of severe static this effect may be very annoying, since when the paralysis sets in, all signals stop. It is possible to discharge the grid, and thus to place the detector in operation again, merely by placing the fingers across the small stopping condenser in the grid circuit; sometimes, even, the bulb will automatically regain its sensitiveness in a second or two after charging. Occasionally, however, there are found very high vacuum tubes which



This special audion circuit overcomes the tendency of the grid to charge too rapidly and paralyze the bulb

will not free themselves of this paralyzing charge. If atmospherics are strong and frequent it is sometimes impossible to read a single word without interruption

One remedy for the paralysis is to shunt the small grid condenser by a very high resistance, which permits the charge to leak off and so prevents all but the strongest impulses from affecting reception. This scheme is used a great deal, but at times is not entirely satisfactory for the reason that when the charging surges are intense, it is necessary to reduce the shunting resistance to so low a value that the sensitiveness of the audion is spoiled. In U. S. patent No. 1,127,371, issued during 1915 to G. W. Pierce, there is shown a new way to do away with the interruptions due to charging. The drawing shows the invention, which is based upon the observation that when the audion is paralyzed the "B battery" current in the telephone circuit is reduced practically to zero.

Referring to the diagram, the antenna 20 is seen to lead to ground 21 through the primary 22 of a receiving transformer. The secondary of this instrument 23, is shunted by the tuning condenser 24, and the terminals carried to the audion grid 13 through condenser 25 and to the filament 14 in the usual manner. Battery 18, acting through variable resistance 17, is used to light

the filament; and battery 31 supplies the telephone current through recording relay 31, telephones 40, discharging relay 51, ballast resistance 39 and plate 12 of the audion bulb. The contact of the discharging relay 54, may be arranged simply to short-circuit the condenser 25, or (as in Fig. 1), actually to place upon it an opposing charge from battery 61, regulated by the potentiometer 60. The recording relay 32, operates the sounder 34. It should be noted that both relays are of the back-contact type, which close their local circuits when the current through their magnets is reduced or interrupted.

The operation of the receiver, with weak or moderate incoming signals, is exactly like that of the simple audion. Unless impulses of sufficient strength to paralyze the tube are received, the relays do not close. As soon as a violent impulse arrives, however, the large positive charge assumed by the grid chokes off the flow of current from battery 31, and the armatures of the two relays spring back and close their contacts

The discharging relay reverses the grid charge and, in this way, permits the audion to regain its normal sensitive condition immediately; the recording relay causes a click of the sounder. Evidently the system of connections shown allows the reception of strong signals by listening to the sounder, yet prevents interruption of the receipt of messages of single violent impulses. It is, of course, necessary to adjust relay 51 to contact very quickly, so that the brief click caused by each closing will not interfere with the reading of messages.

The Non-Synchronous Rotary Gap

THE effectiveness of this popular type of gap depends mainly upon the adjustment of the electrodes and the speed at which the disk is driven. While with it, the absolutely clear note of the synchronous type cannot be obtained, the adjustment should be such that a comparatively even tone may be secured. The somewhat "raggy" spark given by this gap is not entirely disadvantageous, as it is very effective in working through certain kinds of static. With regard to the speed at which the disk should be driven: although a high speed will naturally increase the shrillness of the note produced, there is a considerable loss in radiation at very high speeds, owing to the fact that there is not sufficient time between the sparks in which to charge the condenser to its highest voltage. The use of too many points on the disk amounts to the same thing, and should be very carefully guarded against.—N. A. WOODCOCK.

Wireless Log of 8KY 1915

Date	Sta Cld	By	Time	Pri	Sec	Var.	Clg	Remarks
Dec 3	QST	NAA	1 55A	10-10	8	72	0	Time Signals
	NEA	WEE	4 20P	3-5	3	5	2	
	NAA	NAX	9 45P	12-9	9	60	3	Official
	QST	NAA	9 55P	10-10	8	69	3	Time & Weather
Dec 9	8KY	8AY	8 20P	1-6	2	0	0	

A neat and complete record of messages received can be kept in this manner

A Wireless Log for the Amateur

THE experience of listening is much more valuable if a careful record is kept on some such log as that illustrated. The abbreviations used in the heading are translated as follows: Sta. Cld., station called; Pri., primary of loose-coupler; Sec., secondary of loose-coupler; Var., variable condenser; Clg., coupling. This log was used with a navy-type coupler, and complete entries made on the following plan: For example, take the third note, in which N. A. A. was called by N. A. X.; the 12-9, under Pri., means that the best signals were received at the twelfth point of the multi-turn switch and the ninth point of the single-turn switch. The numbers, under Clg., give the length of the coupling in inches. In a coupler which has a slider instead of switches on the primary, the slider-rod may be calibrated. This simple chart is easily handled and from it many interesting observations can be drawn.

Quenched Gap Damping

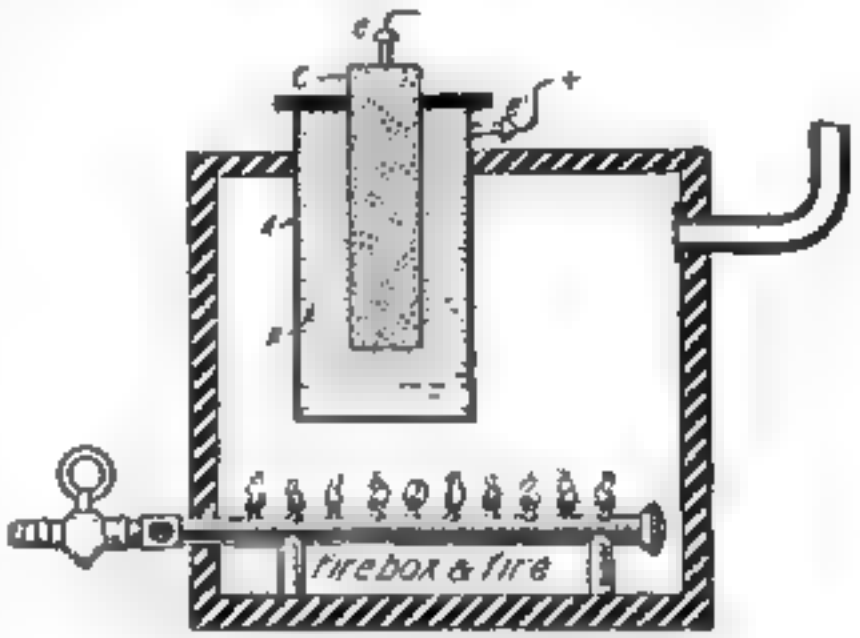
A GOOD quenched gap set will give decrements as low as 0.03, for which value there are over 75 waves to the train.

The "Ideal" Battery

By A. R. MacPherson

TO the experimenter in the field of electro-chemistry there is much unexplored knowledge which in time will prove of inestimable value to the chemistry of commerce, particularly in the methods of generating electricity through chemical actions, which at the present day, though apparently satisfactory, are very inefficient. There are scores of patents on devices for generating electricity chemically, but the majority are lacking in the fundamental principles necessary to the attainment of an efficient commercial product.

The primary cell to be realized is one in which carbon and oxygen are the elements consumed, a much greater amount of energy being obtained if these two elements unite, with the production of an electric current. No other form of energy, such as heat or polarization, to impair the efficiency of the cell, would be manifest. The problem is to find an electrolyte which will dissolve the carbon as ions and to construct the necessary oxygen electrode; thus, the two opposite poles of the cell would carry on the reaction through the intervening electrolyte and no local action would be produced. All of the energy of the cell would be dissipated if the carbon and oxygen acted directly on each other.



View showing Jablockkoff's cell arranged over a furnace

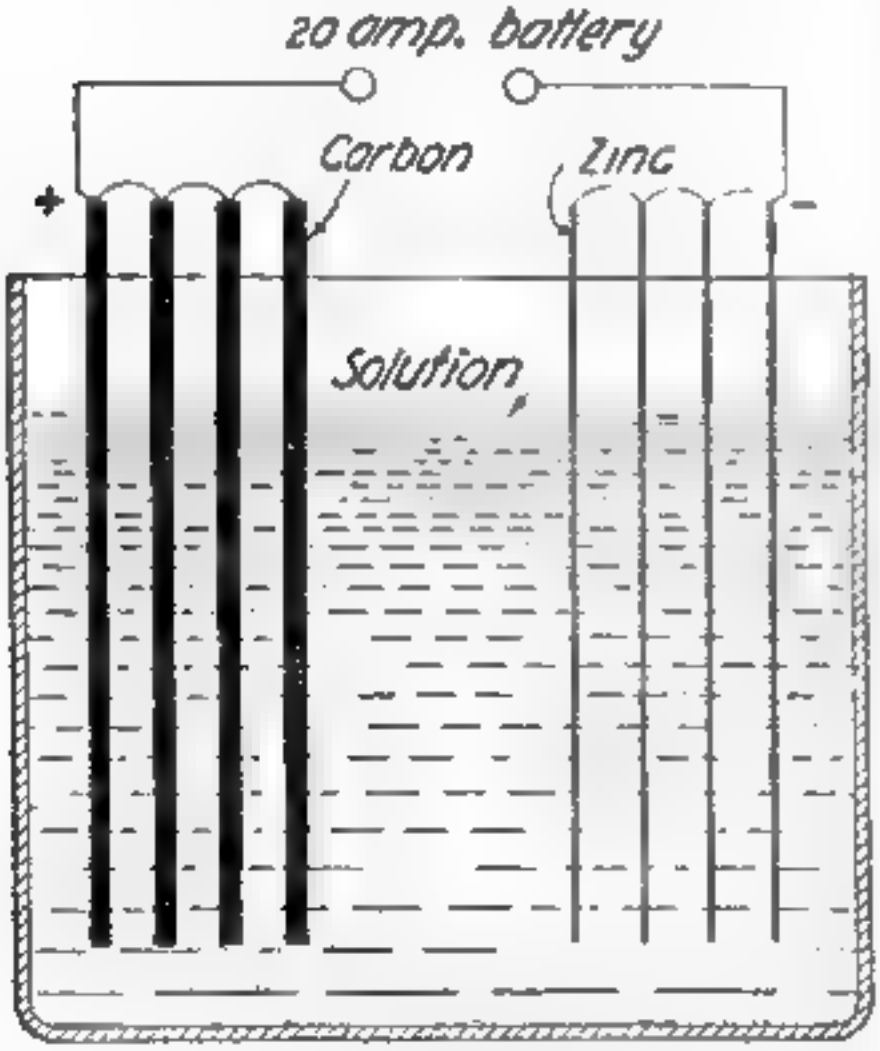


Diagram illustrating the arrangement and connections of plates for oxidizing process

The author has carried out a series of experiments in this field involving the production of an electric current through the action of an electrolyte on zinc plates, the carbons forming the positive pole. Only the carbon plates were acted upon, in that the oxygen stored up within the pores of the carbon was set free, this action considerably increasing the current strength of the battery.

The oxygen was impregnated in the pores by an oxidizing process in which the battery of carbon and zinc plates was immersed in a solution consisting of chromic acid, chrome alum, and sulphuric acid, the plates being connected in parallel to an outside source of current giving about twenty amperes. After allowing the current to run through the cells for fifteen or twenty minutes the battery was removed from the solution, washed, and immersed in the electrolyte, which was a simple salt solution. The E. M. F. produced for a short period was more than double the strength of the regular action in which the carbons had not received this oxidizing treatment. It is probable that the salt solution acts on the zinc, releasing hy-

drogen, decomposing the salt, and at the same time setting free the oxygen in the carbon plates. The fact that the carbon plates can be treated continuously by this process without impairing their efficiency seems to indicate that the oxygen does not unite with the carbon, but is simply stored up within its pores.

This type of battery indirectly illustrates the chemical action of a more ideal cell, but is lacking in some of the necessary fundamental principles; the method employed is inefficient, and the results obtained do not measure up to the applied forces.

There are certain chemical substances which might prove, by analysis, to be adaptable in an application of this kind. Platinum "black," for instance, possesses to the highest perfection the power of promoting combination between oxygen and other gases, absorbing over two hundred times its volume of oxygen, the oxygen simply condensing in the pores where it may be available for combination with other gases. An organic compound known as linoleic acid possesses the peculiar property of absorbing oxygen from the air in large quantities, forming a solid substance. The properties possessed by these two compounds simply illustrate the many possibilities lying dormant in the chemical world which on application to the field of electro-chemistry might prove invaluable.

It may be of interest to note several attempts that have been made in the past on this idea. Jablockkoff in 1880 constructed a carbon oxygen cell using a fused salt as an electrolyte, the carbon being immersed in melted potassium nitrate, the positive electrode being iron. Thus, the oxygen was supplied in the form of a nitrate, but this was not successful as the carbon was brought into direct contact with the oxidizing substance, and it was necessary to keep the cells at a temperature of several hundred degrees.

In 1896 W. Jacques patented a cell which was constructed of an iron pot containing a melted mixture of potassium and sodium hydrate into which the carbon dipped. Oxygen was made to unite with the carbon through the intervening electrolyte, by blowing air against the iron pot which formed the positive pole, and thus producing an electric current. But this was not successful as the salt was changed to a carbonate, and also a certain amount of direct oxidation of the carbon took place.

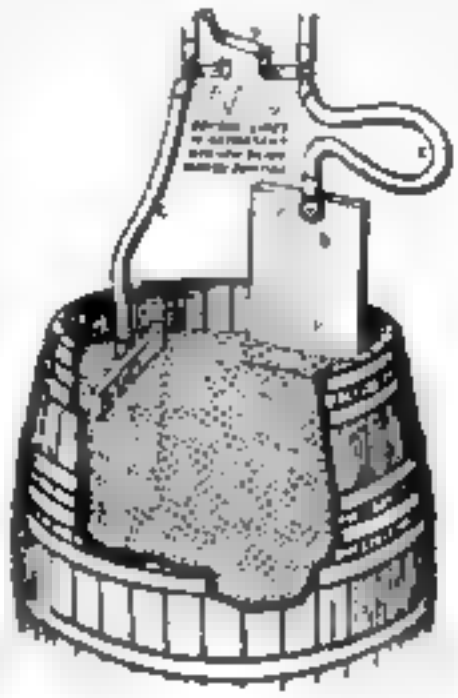
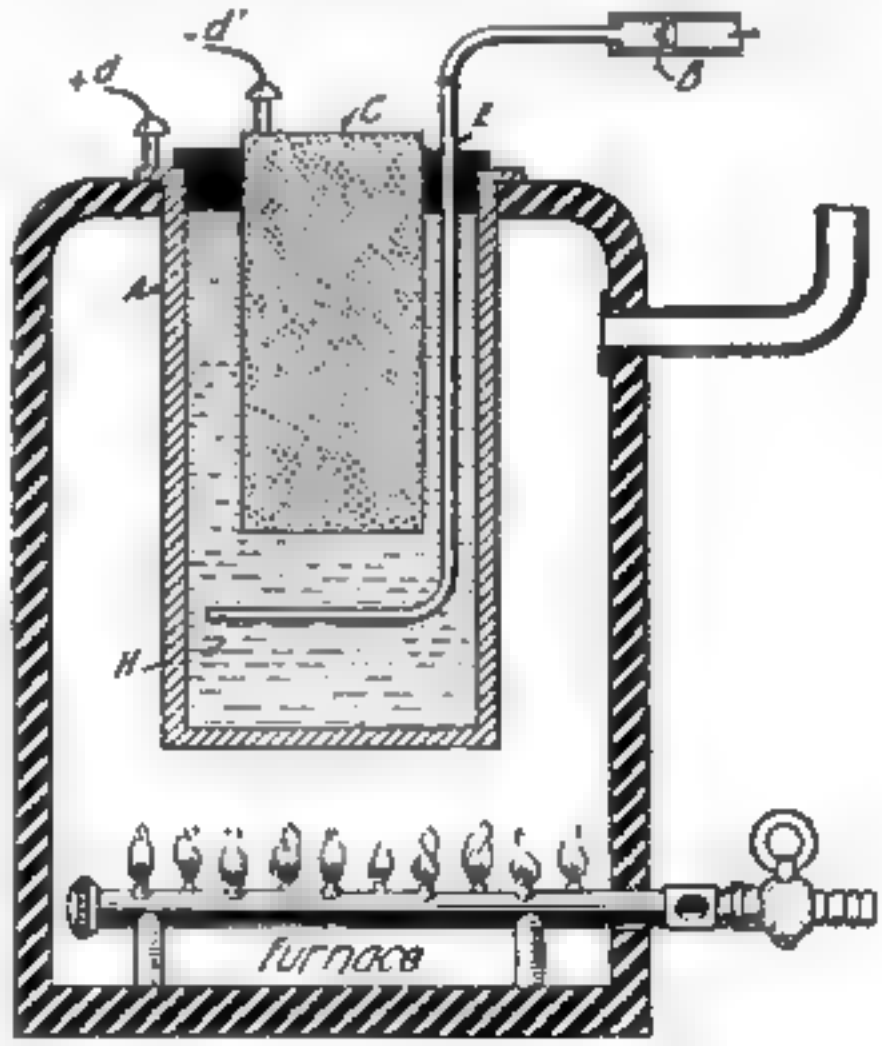


Diagram showing cell arrangement on a large scale

Thus it is evident that the problem of constructing an efficient cell of this type is far from being solved, as it seems almost impossible to find a substance which will dissolve carbon, and thus create a direct transformation of chemical energy into electrical energy. But if some ambitious experimenter with a thorough knowledge of chemistry would go after the solution of this problem with the same persevering research that Edison employed in his experiments with the incandescent light, there is every reason to believe that he would attain success. And the reward would be well worth the effort, as the present commercial world is waiting for such an efficient device that will fulfill all of the necessary requirements.



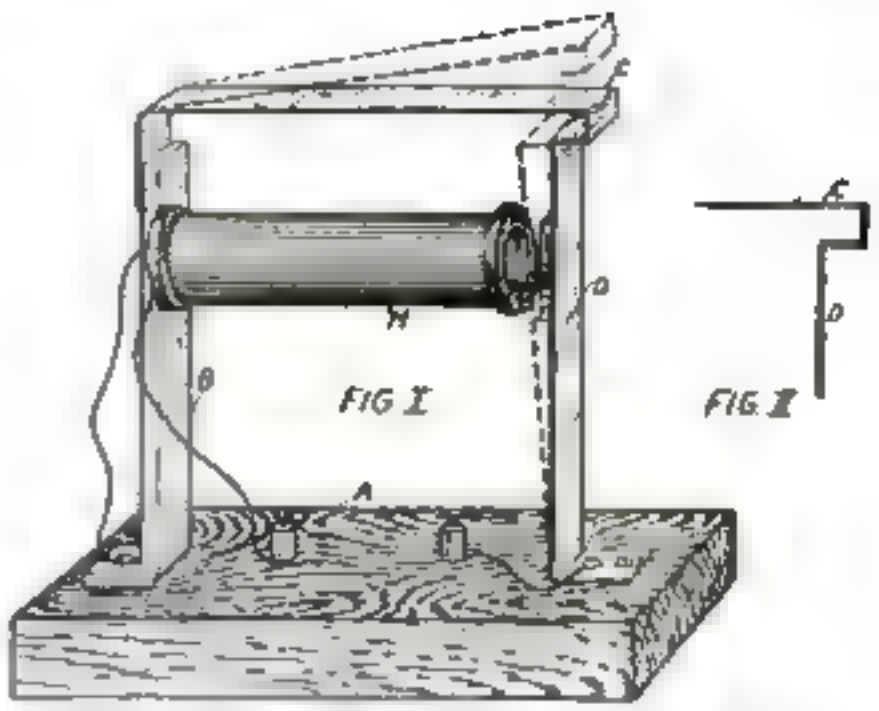
Sectional view of Jacques' ingenious cell, showing heating of hydrate mixture

The Construction of an Automatic Battery Circuit-Breaker

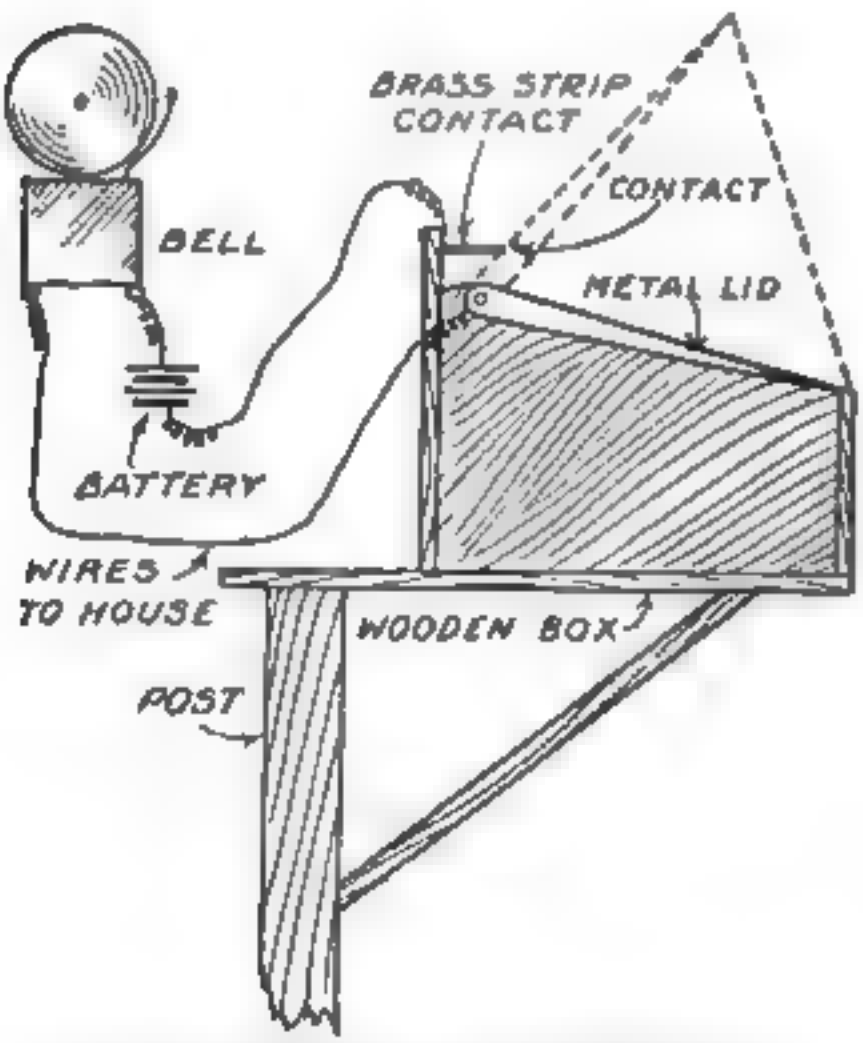
AN automatic circuit-breaker and its operation are depicted in the accompanying diagrams.

Referring to Fig. I, *A* is a wooden base 4 ins. by 2 ins. by ½ in., *B* is a brass strip ⅛ in. by ¾ in., bent as shown so as to stand 2¾ ins. above the base. The magnet *M* is 2¼ ins. by ⅜ in. and wound with 4 layers of No. 16 annunciator wire and screwed to *B* at a point 2⅛ ins. above the base. The strips *C* and *D* are of spring brass, 1/64 in. thick by ¾ in. wide, their ends being bent as shown in Fig. II. The strip *D*, has a piece of soft iron *E* screwed fast to it at a point opposite the magnet core. The strip *C* is bent so as to have a tendency to spring up when *D* is drawn into the magnet. The wiring is clearly shown in Fig. I.

In operation, the circuit-breaker is placed in series with the battery and the circuit which is to be protected, close to the battery. Should a short-circuit occur on the line, the excess current flowing through the magnet energizes it more strongly than when the normal current flows, drawing *D* inward, thus releasing *C*, and so breaking the circuit.—E. B. WILSON.



When a short-circuit occurs, the circuit is broken automatically by means of this simple device



When the postman raises the mail-box lid a bell rings in the house

How to Make a Rural Mail-Box Alarm

TO those living in rural or suburban districts, where the mail is deposited in a wooden mail-box by the roadside, the device here described will be of interest. The idea is to have an announcing bell at the house when the mail is placed in the box, and thus make a long wait in the cold unnecessary. An electric bell is put in circuit as depicted, using a dry battery as a source of energy. It is advisable to use a roll of insulated bell tape to insulate the wires properly. Two dry cells will be sufficient for any distance up to 200 ft. Cut a thin brass strip and bend at the center. Fasten to the top-extension of the mail-box and connect with the battery. Replace the wooden cover of the mail-box by a brass or metal one. Both the brass strip and metal cover must, of course, be connected with the house by two separate wires. The wires to the house are simply tacked by staples on to small posts. Following is the modus operandi: As soon as the mailman lifts the lid to place the mail in the box, the metal lid comes in connection with the brass strip and closes the circuit, operating the announcing bell at the house.—WM. WARNECKE, JR.

Japanese Wireless Telephone

THE Japanese Navy is equipped with apparatus for radio telephones, with which wireless speech can be transmitted dependably about ten miles and often three times this distance.

An Electric Weather-Vane Indicator

A WEATHER vane can be constructed as shown in Fig. 1 or an old existing vane can be used to serve the same purpose. A circular wooden disk 4 ins. in diameter is mounted on the upright of the vane. This disk has eight copper segments fastened to it as shown in Fig. 2. The whole thing is mounted so that the segment marked *N* is pointing to true north; the other segments will then take the proper directions. The direction which the wind is blowing will be indicated by the ringing of the bell, since the circuit is closed when the switch handle is brought around to the point corresponding to the same point on the vane.

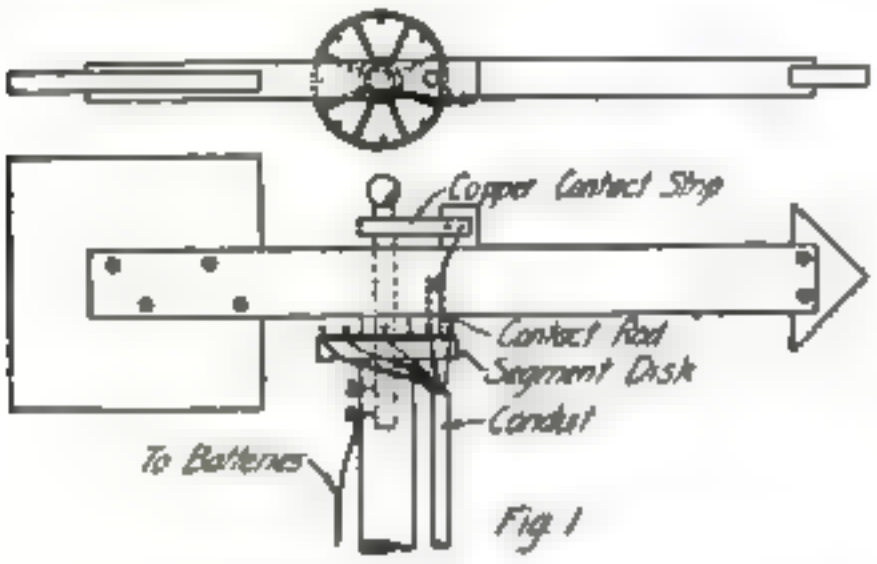


Fig. 1. The ringing of a bell indicates which way the wind is blowing

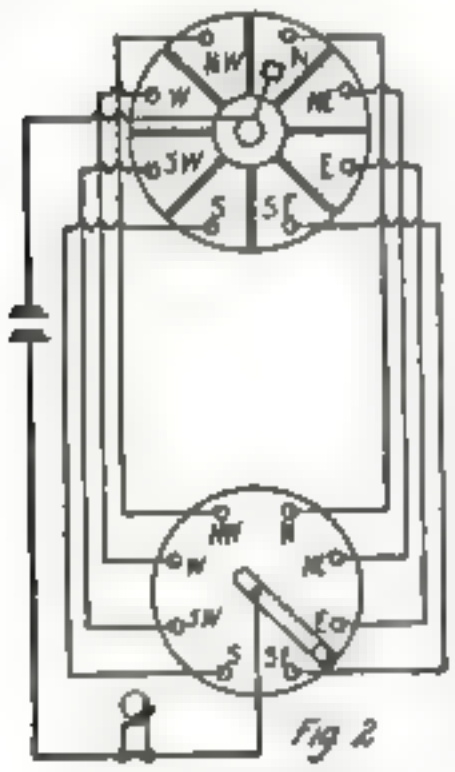


Fig. 2. Diagram of connections

If the direction of the wind is such that the rod is brought in contact with two segments at the same time, it will cause the bell to ring when in contact with both points on the switch. Such a condition indicates that the wind is blowing directly between the two directions indicated by the ringing of the bell. For example, the switch at *N* will cause the bell to ring, and also at *N. E.* The direction of the wind is then *N. N. E.*

By this method the direction of the wind can be more accurately determined than by actual observation and also does not make it necessary to see the vane to determine the direction of the wind. The method of wiring is shown in Fig. 2.—J. M. Cohen.

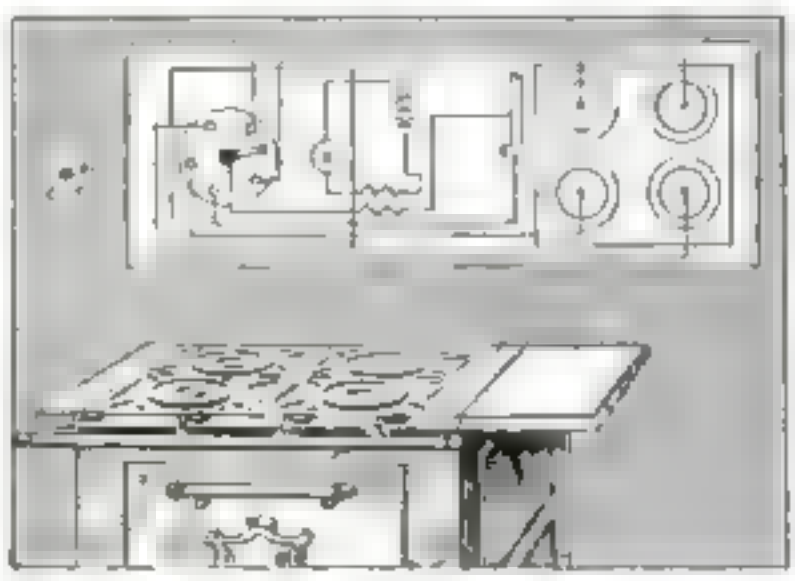
Electrical Lighting Device for the Gas-Range

NO woman appreciates the convenience of an electrical lighting apparatus for the gas-range until she has actually used one. Following is the description of one which is easily made:

In the diagram is shown a 5-point switch and a common push-button installed on a suitable base. For this purpose, a small board can be attached to the wall near the stove. The push-button is connected in series with three or four dry batteries and the primary winding of a spark-coil that will give at least a ½-in. spark.

The battery, the primary winding, the four burners and the proper connections are shown in the diagram. Note the pipe connection to the stove, with one wire from the secondary winding of the coil grounded to the pipe, while the other end of the winding is connected with the center of the 5-point switch. The wires from the switch to the spark-gap at the burners must be well insulated, and at least an inch apart.

The gaps at the burners are made from No. 10 steel wire and insulated from the stove with hard fiber. The steel wire to the gap must come up into the center of the burner from below, so that the flame will not harm the wire or gap. When it is desired to light a burner, simply turn the switch to the proper point, turn on the gas, and push the button.



Any amateur electrician can fit the gas-range with a lighting device

Radio Tower at Tufts College

THE radio tower recently erected at Tufts College, Medford, Massachusetts, is attracting unusual attention. In September, when the tower was completed to a height of over 275 ft., one of the temporary guy ropes parted during a high wind and allowed the tower to topple over. Instead of snapping at some point above the ground the structure pulled away from the sub-base and fell as a complete unit

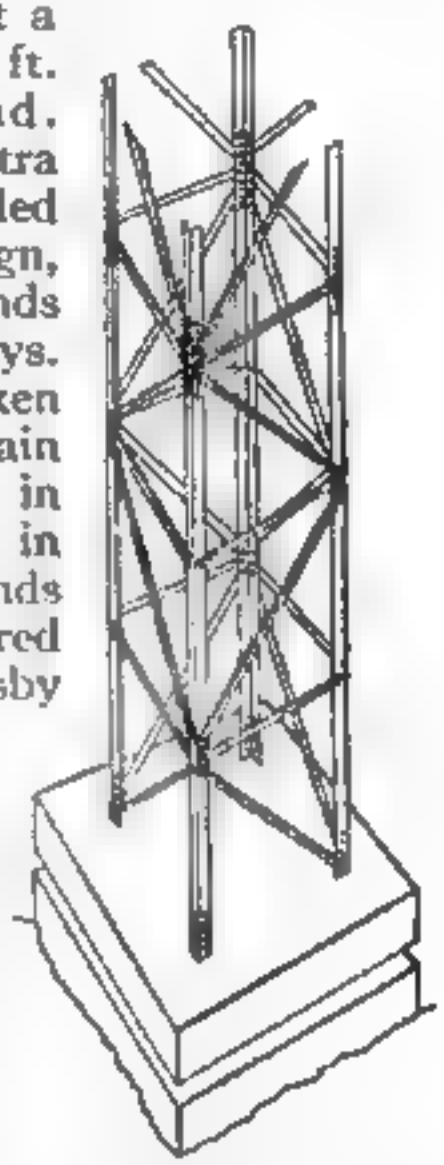
It has been shown that the collapse was not due to faulty design, and the tower has been re-erected without important changes

The tower itself is built entirely of angle irons and assembled in the manner shown in the illustration. It is 288 ft. above the concrete base, and 3 ft. 4 in. square in section from base to top. The corner, or upright, angle-irons are 3 ins. by ¼ in., while the diagonal and cross angle-irons are 2 ins. by 3/16 in. The corner angles are each nearly 12 ft. long and, as shown by the diagram, are divided into three sections. The sections are placed directly on top of each other and held together by means of angle-irons fitting inside of the corner angles and extending several inches either side of the joint. These angles are secured by bolts ½ in. in diameter and 1 in. long. This bolt construction is employed throughout the tower, there being no rivets. Washers are not used with the bolts.

The structure is mounted on two concrete bases. The upper base is 5 ft. 4 ins. square and 12 ins. thick. It is to this base that the iron work of the tower is secured. This sur-base rests on four porcelain insulators set so as to leave 5 ins. between the two bases. The lower base is the same size in section as the upper base, but extends 6 ft. into the ground. When the first tower collapsed these two bases pulled apart.

As the tower is not self supporting, the system of guying is of great importance. Three sets of four guys each have been adopted, thus giving 120-degree guying with four guys fastened to each of the three deadmen. These guys consist of stranded steel cable with rope core, the two upper of which are ¾ in. in diameter and the two lower ⅝ in.

After the complete erection of the tower the fourth guy was added to each of the three sets at a point about 75 ft. from the ground. These guys are extra and were not included in the original design, but as it now stands the tower has 12 guys.



Construction details of the tower

The guys are broken up by porcelain strain insulators 5 ins. in length and 3 ins. in diameter. The ends of the wire are secured by a series of Crosby clamps. Twelve-inch turn-buckles are inserted in each set of guys

The three deadmen are made of concrete and weigh about 25 tons each. On the surface they are 5 ft. 3 ins. square. They are placed 150 ft. from the base of the tower so as to give an angle of 45 degrees to the lower guy, which is placed mid-way up the tower.

The tower was erected aloft, each separate piece being placed in position before another was secured. Temporary guy ropes were used in large numbers during the erection of the second tower, as it was due to insufficient temporary guying that the first structure collapsed.

Harold J. Power, for whom the tower was erected, is a graduate of Tufts College. While there he was president of the Wireless Society, to which organization he has granted the use of the new tower and experimental station.

Many methods of mast construction have been tried, and while a serviceable tower of wood can be built, wood is generally considered inferior to steel.

What Radio Readers Want to Know

Crystal Receivers

W. L. K., Cincinnati, O., inquires:

Q. 1. What is your opinion of the carborundum crystal as compared with other mineral detectors? Are a battery and potentiometer required for the maximum degrees of sensibility? What color is the most sensitive? I have been told that a flat piece of metal is used for making contact. Is this correct?

A. 1. The carborundum detector is not as sensitive as galena, cerusite, silicon, perikon, etc., but for commercial use is more desirable. The adjustment is rugged and not easily influenced by the local transmitting apparatus or heavy atmospheric discharges.

Good results with this crystal can only be obtained by applying a local battery. Generally, one battery cell shunted by a 400-ohm potentiometer fitted with a sliding-contact will permit the necessary control of the current. It is equally important that the current flow through the crystal in a definite direction; the proper direction is best determined by experiment.

Crystals of the dark blue variety are found to be the most sensitive. It is customary to mount the crystal in a small metallic containing cup with some form of "soft metal." A sharp point such as that afforded by a steel phonographic needle with a rigid spring adjustment, is the most desirable.

Safe Towers

C. S., St. Louis, Mo., writes:

Q. 1. I would like to know if I can safely erect a 60-ft. mast for the support of an aerial system if the first 20 or 30 ft. consist of 3-in. gas pipe and the remainder of 2-in. gas pipe.

A. 1. A structure of this design is not recommended unless it is very carefully guyed. Pipe unions should not be used. If a single section of the desired length cannot be obtained, that is to say, if a single 30-ft. section is not available, the mast should be constructed of several sections of the correct diameter to fit inside of each other. The sections should be telescoped for a distance of about 2 ft. and held in position by iron bolts passing directly through the pipe. This construction will eliminate the weakness of reducing couplings and pipe unions. A 60-ft. mast of this type should have two sets of guys. Great care must be exercised in the erection, for iron pipe will not stand a horizontal strain when the sections are of considerable length.

We know that this is a vital matter to amateur experimenters, but obviously in the space at our disposal in this department a complete set of drawings for the construction and erection of a mast cannot be given. Wind-mill towers can be purchased at reasonable prices, and it might be of benefit to you to get into communication with the manufacturers.

Antenna Wavelength

E. B. K., Gulfport, Miss., inquires:

Q. 1. Please calculate the fundamental wavelength of a six-wire aerial, 90 ft. in height at one end, 45 ft. at the other with the flat top portion 150 ft. in length. I believe that its wavelength is in excess of the U. S. restrictions, and should like advice concerning the method of cutting it down to comply with the law.

A. 1. The fundamental wavelength of this aerial is approximately 410 meters which is far in excess of the U. S. restrictions. You are advised to reduce the dimensions of the aerial, making the flat top portion from 50 to 80 ft. in length and the vertical portion from 40 to 60 ft. in height. If it is intended to employ this aerial for the reception of signals from long distance stations, the construction should not be changed, but for the transmission and reception of signals on the restricted 200-meter wave, the dimensions of the complete system should not exceed those last given.

Armstrong Receivers

C. J. G., Chatham, N. Y., writes:

Q. 1. In the December, 1915, issue of the POPULAR SCIENCE MONTHLY you published a drawing of the Armstrong circuit. Will you please advise if the coils L 2 and L 3, L 6 and L 7, are constructed after the form of inductively-coupled receiving tuners? If not, in what relation are these coils placed?

A. 1. It was intended that these coils be constructed in the form of inductively-coupled receiving tuners. L 2 and L 3 should be so constructed that L 3 may be placed completely inside of L 2. In actual practice L 6 is generally placed about 1 in. from L 7, but under certain circumstances it may be necessary to place them in closer inductive relation.

Sending Transformer and Condenser

L. J. T., St. Louis, Mo., writes:

Q. 1. Please give a minute description of how to build a 1 k. w. wireless transformer suitable for radio work.

A. 1. Assuming that this transformer is to be operated at a commercial frequency of 60 cycles, you are advised to adopt the open core type of transformer because it possesses inherent characteristics peculiarly suitable for radio work. The following dimensions are good for a 1 k. w. transformer to have a secondary voltage of 20,000. The primary core consists of a circular bundle of No. 28 or 30 soft iron wire 3 ins. in diameter by 25 ins. in length. This should be covered with two layers of Empire cloth or friction tape. The primary winding is then covered with an insulating tube of micanite or hard rubber 3/16 in. thickness. The secondary winding consists of 38 pancakes of wire each 1/8 in. in thickness, having approximately 1100 turns of No. 30 S. C. C. wire.

It is preferred to divide this winding into six sections with about six pancakes in each section. These pancakes should be spaced on a fiber disk about 1/16 in. in thickness. If cotton covered wire is employed it should be dipped in hot paraffin just previous to the winding.

The Home Workbench

How to Make an Accurate Sun-dial

THIS sun-dial can be made easily and it will give accurate results. While the variation of time in all parts of the United States will be slight, the most accurate reading will be made between the 35th and 45th parallels of northern latitude as this is the area it is designed to cover.

Any material will suffice to make the dial and style from, and any thickness may be used. But the most neat dial can be made from brass or copper, cut from a sheet or cast from patterns. The parts should be at least ¼ in. thick to be substantial. The degrees of time, as well as the dimensions for making, are shown on the accompanying drawing. Care must be taken that all lines are drawn straight and the dimensions followed closely. After the hours are put on, the spaces can be subdivided into halves and quarters and five minutes if desired. The space left in between the A. M. and P. M. hour divisions is to receive the style and should be just as wide as the style is thick. The best way to mount the style is to tap two holes in the lower edge and bolt through the dial with small machine screws. The style may be ornamented with several hollows cut out, but the top edge or shadow casting edge must be perfectly true. The long vertical end of the style goes at the 12M mark on the dial.

The whole can be erected upon any suitable stand, wood, stone or cement which can be worked up into an ornamental design. The 12 noon end of the style must point exactly north and the other end to the south. Or the dial may be set to local time by waiting until exact noon and then setting the dial accordingly.—B. F. DASHIELL.

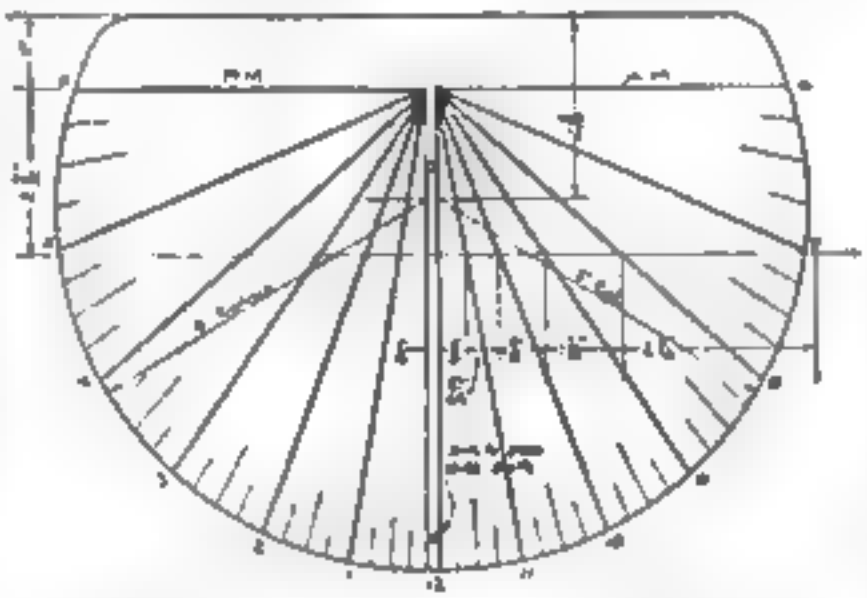


Diagram of sun-dial, showing dimensions for construction and angles for determining each hour mark

A Waterproof Compound

A GOOD waterproof compound can be made if the following directions are carefully observed. It is suitable for any job not larger than an ordinary cellar, or where the water pressure is not too great, and is especially adapted for wells, cisterns, cement ice-boxes, etc.

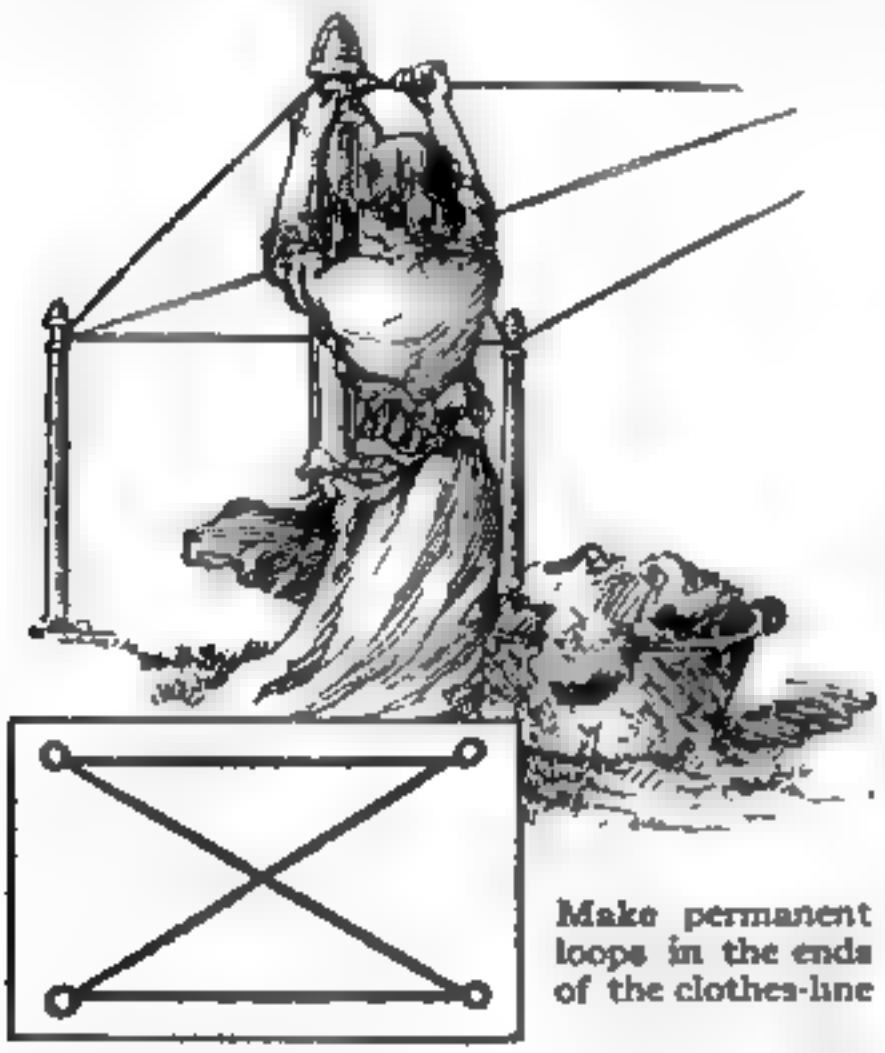
First dissolve soap in water until a good soapy liquid is obtained. This can easily be done by chipping common yellow soap into a wash boiler and allowing it to boil. About one bar of soap to every bucketful of water is enough, but a half bar more will do no harm. When ready to mix, add one bucketful of soap solution to every two bucketfuls of clear water. When applying the mixture, it is essential that it be well troweled. The smoother the finish, the more lasting the result and the better the water-proofing qualities.

How to Mix Stove Blacking

USE vinegar instead of water when mixing stove blacking. The work of polishing will be easier and the polish will last much longer.—C. A. WOLF.

Clothes-Line Suggestions

IT is stupid for a woman to stoop nearly to the ground every time she lifts a sheet from the basket for hanging up on the line. It is dull to carry the heavy basket of wet clothes all around the yard, or to leave it in one spot and



Make permanent loops in the ends of the clothes-line

take walking tours in a spiderweb path back and forth from basket to line. Besides, it is easy to soil the bottom of the basket if the yard is also a garden. These useless motions are obviated by pulling the basket around upon a little wagon, which is of convenient height.

When comforters and other heavy bedding are washed they do not dry quickly if hung upon a single line. The inside of the folded piece is not touched by sunshine and wind and the texture is too thick for penetration from the outer side. String two lines parallel, about two feet apart. This allows air to circulate up under the "tent." For dresses also this scheme is very satisfactory.

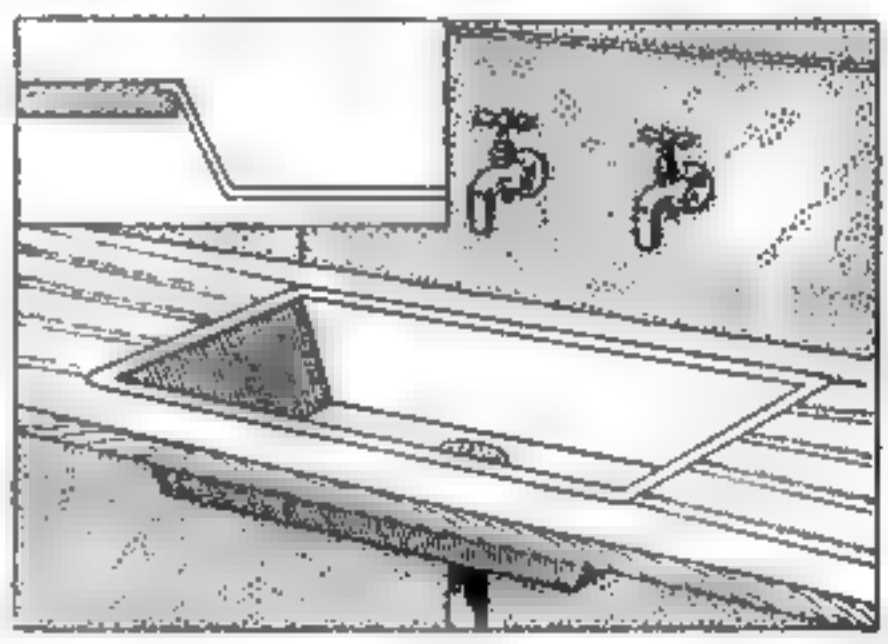
A simple wooden reel and a handy basket to suspend from the line, make clothes-hanging easier

A clothes-pin carrier can be made from a grape basket. Suspend it from the line by a stout wire bent into a loop at each end, and push it along the wire ahead of you.

A small wooden reel on which to wind a rope clothes-line saves the trouble of unraveling the tangles which get in, if it is rolled or looped up in a ball. Permanent loops at the ends of the rope and at intervals, spaced like the distance between posts, will save time and temper in stretching the line and making new knots each week.

A Sanitary Kitchen Sink

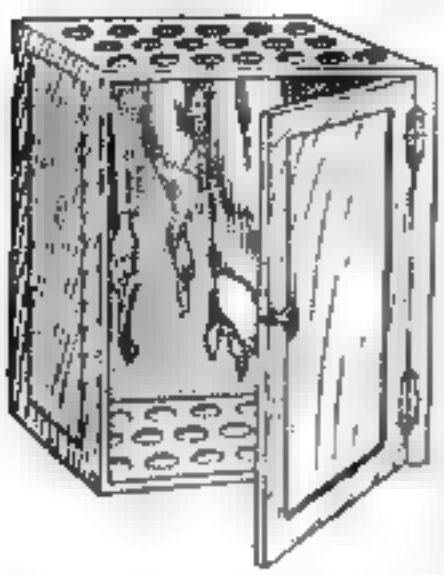
IN setting kitchen sinks it has always been a rule to set the sink under the drain-board, and as the drain-board extends over the edge of the sink, it forms a bad place for dirt and grease to collect which no kind of



The close-fitting drain-board prevents the collecting of dirt

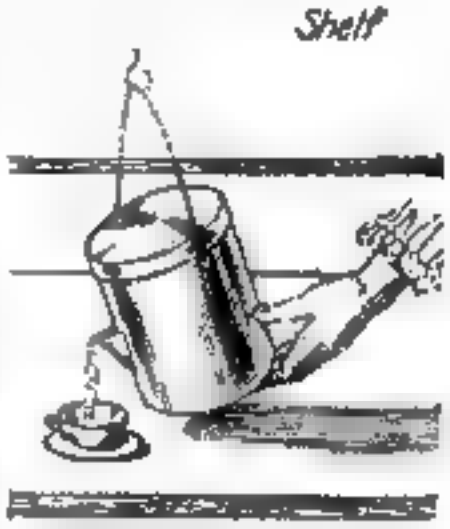
brush or cloth can dislodge. To improve this condition, use a solid drain-board and cut out the center large enough to let the sink through. The flange or rim of the sink will hang on the drain-board about ¾ of an inch all around. Drop the sink into this hole and with a sharp pencil mark around the rim. Rabbet this out about ⅝ of an inch, or so that the rim will go into this rabbet and finish flush with the top of the drain-board. Take thick white lead or soft putty to bed the sink in. This sink will not leak and is sanitary.—Wm. J. Albin.

How to Dry Unsightly Scrub-Rags



THE cloths used to mop the kitchen floor are inevitably stained and unsightly, even when rinsed. To dry them, and still have them hidden from view, bore holes in the top and bottom of a wooden box, stain the outside to match the woodwork and hang it in the warmest place in the kitchen. The warm air rises through the holes and dries the cloths hanging on hooks on the inside. Tea towels and dish rags may be similarly treated.—A. G. VESTAL.

How to Protect Sugar from Ants

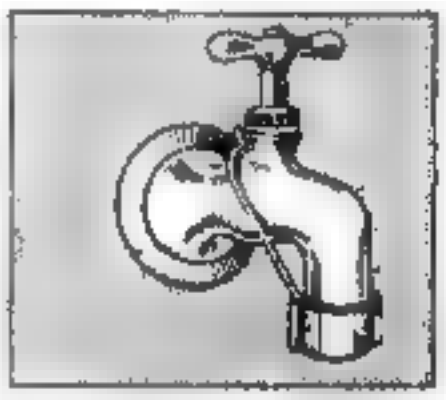


A HANDY receptacle for sugar may be made from an ordinary lard-pail with a tight cover. Cut a slot in one side, a little above the middle, and solder on a spout or lip, made from a scrap of bent tin. The pail may be suspended from a hook on the under side of a shelf above the table. To remove the sugar, the cook simply tilts the pail over a dish on the table. This arrangement effectually prevents ants from molesting the sugar.

A Milk-Warmer Made From a Lamp-Bulb

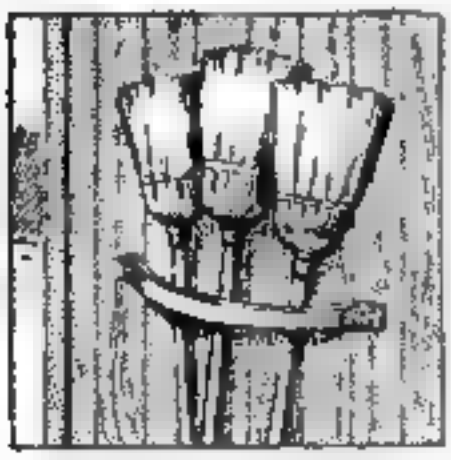
AN electric milk or medicine warmer can be made from a large carbon electric lamp by holding the bulb over a blow-torch and slowly heating the glass as shown in the diagram. The glass should be wiped dry before heating, and if pains are taken in heating the bulb, the soft glass will sag enough to form a basin to hold a small amount of water.—WM. HARRIER.

How to Use Old Mantle Supports



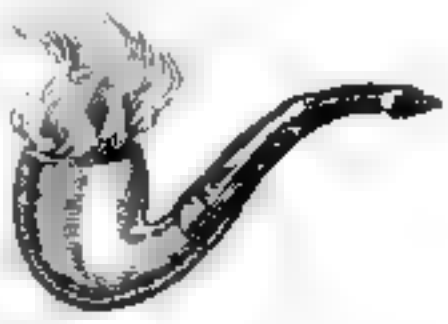
THE used supports for Welsbach upright gas mantles can be utilized on a water-faucet as a strainer and also to prevent splashing. Remove the wire ends from the sheet metal part or sockets which hold them; place the cylindrical part containing the screen over the end of the faucet. Hold it in place by reinserting the wires in the sockets in the new and reversed position. Sometimes an extra turn of the wire is required to prevent slipping down. Though this strainer is not fine enough to filter out bacteria, it will serve many uses where particles of dirt and weeds get in the water.—T. GLYNN.

Broom Holder from Barrel Hoop



BROOMS, when not in use, should be stood on end. A section of a wooden barrel hoop cut and nailed in place as shown in the illustration makes an excellent holder for three brooms; and the cost is nothing.

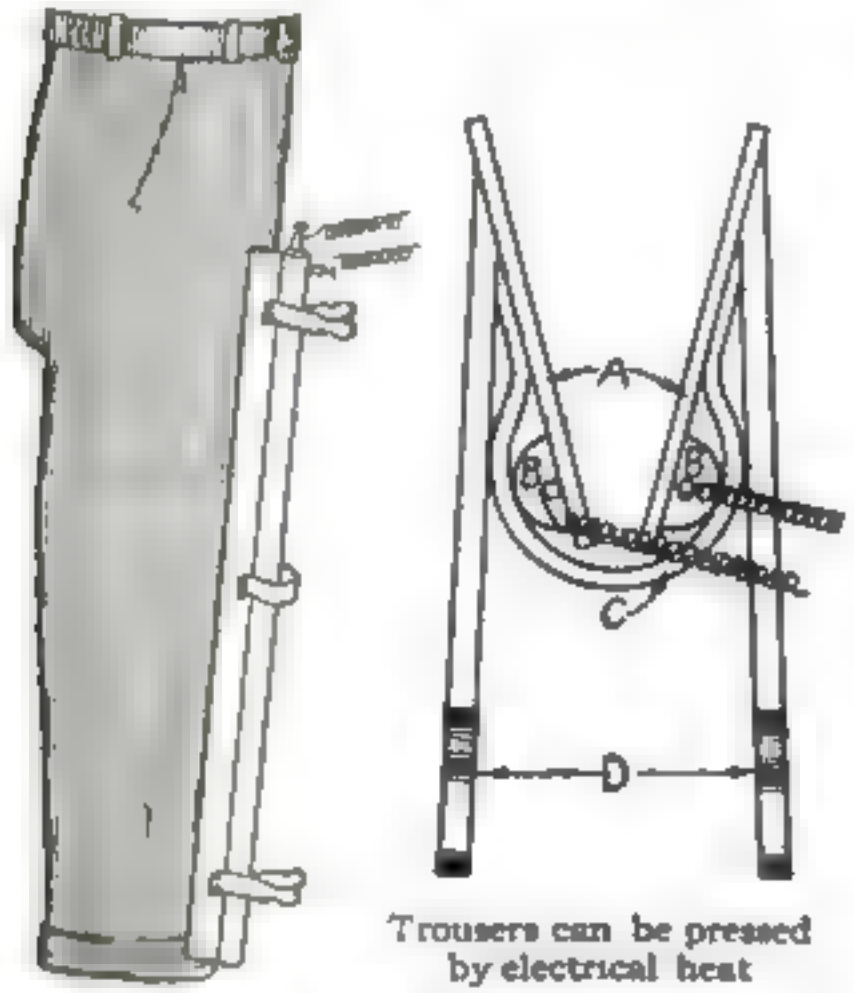
Rejuvenating Your Pipe



TO make an old tobacco pipe as good as new, plug the stem with a bit of match, fill the bowl with alcohol, light and let burn. Do this three or four times and the pipe will be as clean and as sweet as when new, without the bother of breaking it in.—L. E. FETTER.

A Quick Creaser

A VERY convenient article for a household is apparatus for creasing trousers in a jiffy. The illustration shows a very light and easily operated device. It is shown in operation at the left. It clamps the trouser leg and is electrically heated by means of two



Trousers can be pressed by electrical heat

coils of wire, running the full length of the apparatus, as shown at *B*, *B*. The clamp *A* clasps the trouser leg. Three springs as *C*, one at each end and one at the middle, furnish the pressure; *D* indicates the releasing handles.

By dampening the trouser leg with a wet sponge and applying this apparatus, a fine crease can be obtained in a jiffy. This apparatus can be applied to the back of the trouser leg as well as the front.

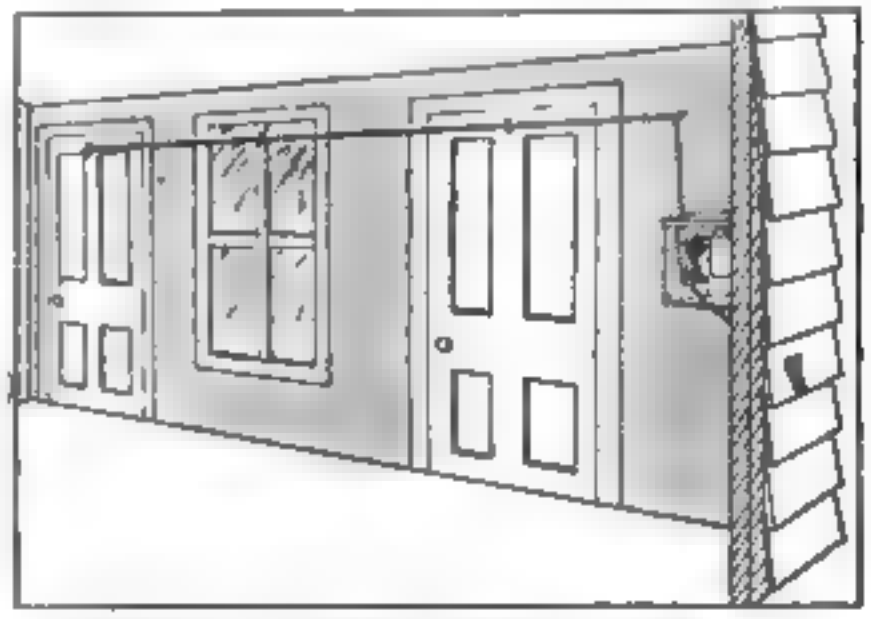
Making the Burglar Call the Police

AN invention soon to be installed in certain government buildings in the South, to make burglars and housebreakers themselves ring up the police calling for their arrest, has been worked out by Louis H. German, Louisville, Kentucky, as the sequel to a narrow escape he experienced from an intended robbery.

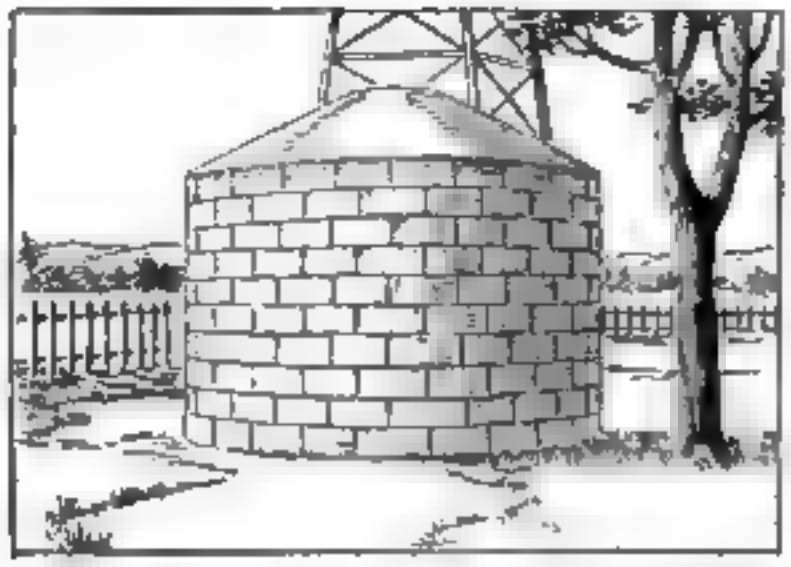
The system involves the automatic sending of the alarm from an instrument concealed in the room or building which has been broken into. This instrument may, for example, be a telephone concealed within a wooden cupboard. An elastic cord is fastened to the receiver (or other suitable alarm-sending element), and to the end of this short elastic cord is fastened a long wire or cord that is run through eyes that are fastened to the tops of doors and to window frames, and its further end hooked fast to the last eye in the end door or window. This wire is put in place by the owner or proprietor before he leaves the room. The telephone receiver hook is held in its place so as to give the alarm when he leaves. For this purpose, a cord is fastened to the hook and run through a hole in the wall to the outside, where it is fastened to a hook or nail.

When the proprietor opens the door, the elastic band attached to the receiver simply stretches without lifting the receiver from the hook, as it is held in place by the taut cord hooked outside the wall. Once he has closed the door and is outside, he proceeds to release this cord from its hook, so that it will slide through the wall inside. The next person who undertakes to open door or window will consequently stretch or strain the wire or cord extending across the doors so it will raise the receiver of the alarm-giving telephone from its hook, as it is no longer held down by the other cord.

In the daytime, the cord that protects the various doors and windows may be withdrawn and stored inside the cupboard that conceals the alarm-sending telephone, and employees and visitors in the building will be unaware of the existence of the automatic burglar-alarm.



By means of this scheme every door and window may be guarded

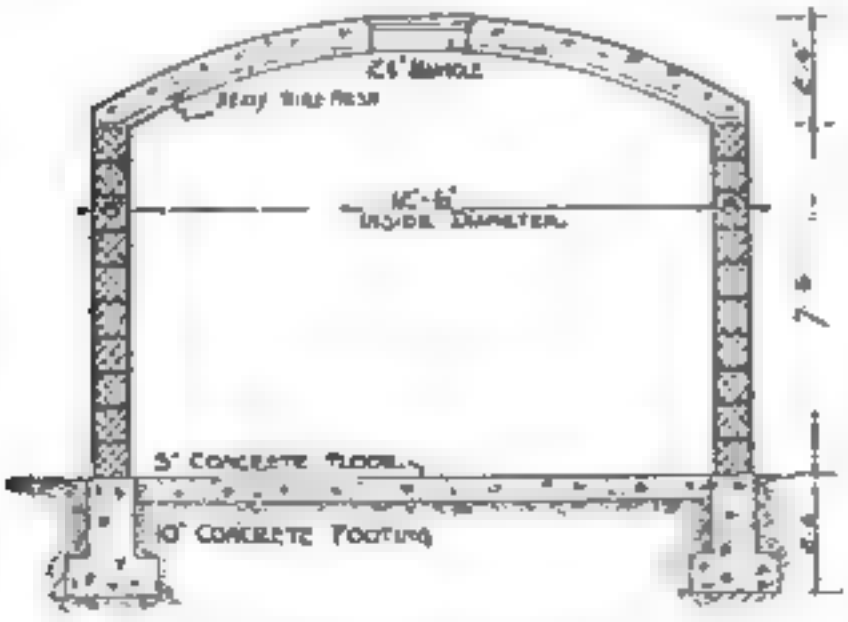


This cistern is made of concrete blocks. Its height is about ten feet

A Cistern of Concrete

THIS cistern, located above ground and on an elevation, makes it possible to have water under pressure in all departments of the farm. Water is pumped into the cistern by the farm windmill, the frame of which can be seen in the illustration. The cistern is built of concrete blocks laid in cement mortar. It is a round structure, the inside diameter being twelve and a half feet, and the height ten. The size is ample for farm use, yet the cost of the improvement is within reach of the average farm owner. The materials should cost about sixty dollars in the middle west.

The foundations and the floor are of solid concrete. Build the foundation walls below the frost line and make them ten inches thick and the floor five inches thick. About 300 blocks will be required for the cistern. When the desired height has been constructed, the next step will be the building of the concrete slab roof or cover. This will be re-enforced with a heavy wire mesh and there will be a 24-inch cast-iron manhole in the center. Build the form work of lumber well supported by timbers and joists. After the concrete has been poured and allowed to harden, the builder can enter the cistern through the manhole and remove the form lumber in pieces. The inside walls should be given a good treatment of cement wash mixed to the consistency of thick cream.

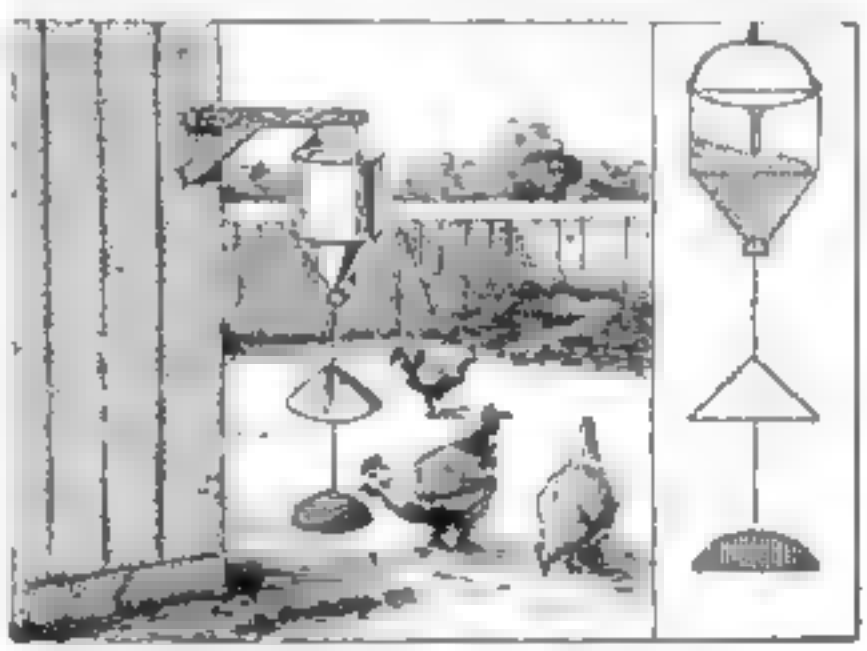


Cross-section plan of the cistern, showing its dimensions

Automatic Feeding-Hopper Built for Twenty-five Cents

PROCURE the following articles at a ten-cent store; a tin pail, a funnel, a pie-tin, and a strainer. The large end of the funnel should be a good fit for the inside of the pail.

Cut out the bottom of the pail and remove the spout of the funnel. Place the funnel in the pail and solder securely. Cut a V in the pie-tin, bring the edges together and rivet or solder them, making a conical deflector. Cut the piece taken from the bottom of the pail so that it will fit on the strainer; fill the strainer with corn and solder the piece



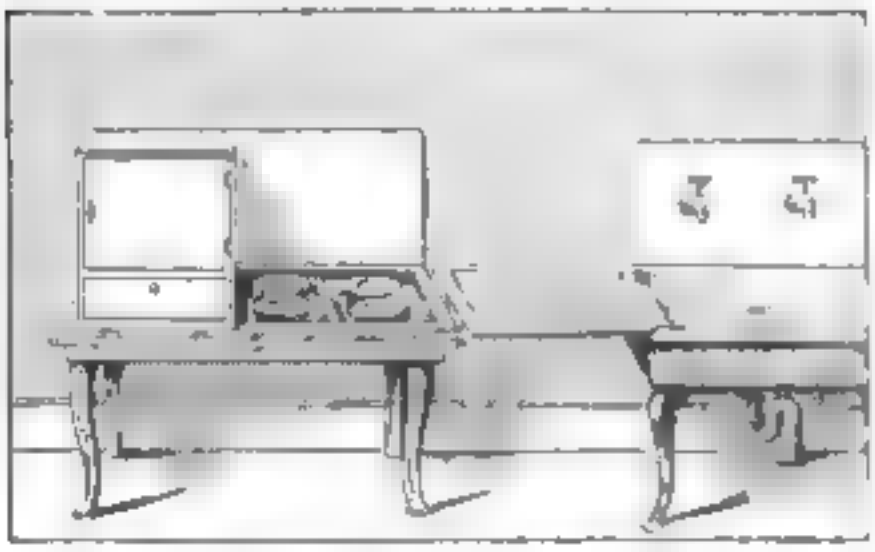
Chickens can be trained to feed themselves by means of this device

on to keep the corn in. A rubber band or light spring and a spool cut in half are also needed.

From the cover of the pail fasten a cord to a rubber band, also run a long cord from the end of the rubber band through the funnel to the spool valve, then to the deflector, and to the bait bar or strainer. The cord is fastened to the spool by the wooden plug. When adjusting, the plug is loosened; or the feeder can be adjusted by the cord on the cover of the pail.

The Left-handed Woman's Home Appliances

A FRIEND who is left-handed says it is foolish, when she must do her own housework for a lifetime, to put up with the little annoyances that come from using tools and arrangements standardized for normal, right-handed housekeepers.



The left-handed woman should have her kitchen arranged for her own convenience

She has her scissors sharpened the reverse of the usual way. The drain-board in her kitchen is at the left, instead of at the right of the sink. The shelf of her range she had transferred to the left. If she used a cabinet gas-range, with high ovens at the side of the open cooking-burners she would choose a stove with ovens at the left. In hanging up small tools near the place where they are to be used, she locates them at the left, rather than at the right side of the table or counter. The usual location of the spout or lip upon sauce-pans or skillets serves a left-handed cook well, for they are wrong for the average woman.—A. G. VESTAL.

How to Make Artificial Marble

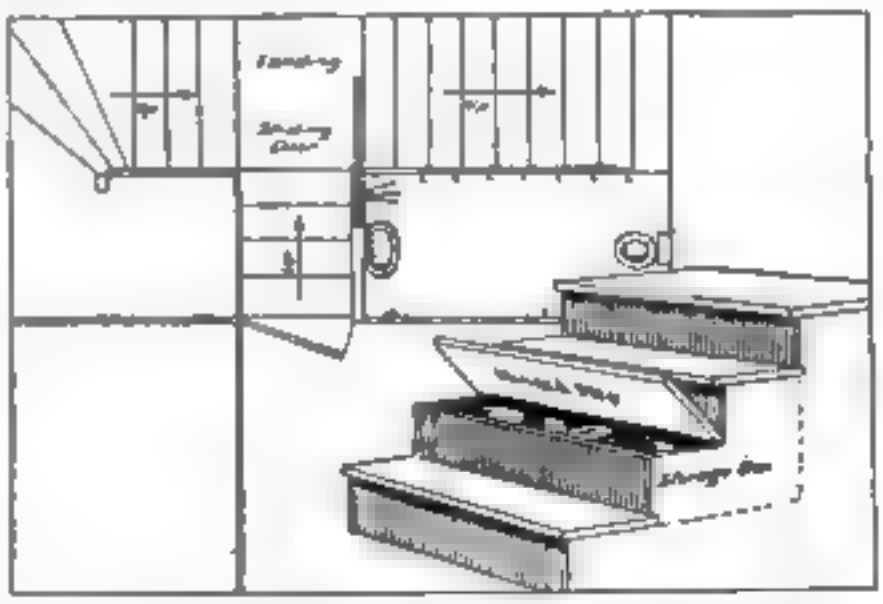
A COMPOSITION closely resembling marble can be made from marble-dust and magnesite. Thoroughly mix equal parts of these ingredients while dry. Make a watery solution of magnesium chloride, strong enough to float an egg. Add the magnesite and marble-dust mixture to the magnesium chloride solution, until a thick, creamy composition is obtained. Pour this into molds of glass. The glass should be washed, polished, and rubbed with a cloth soaked in paraffin oil. The oil gives the appearance of polished marble, when the composition is hard. Twenty-four hours are required for hardening.

If a mottled or veined effect is desired, add dry mineral colors to a small amount of the mixture, and, with a spoon, deposit it in several spots. When the mixture is poured into the molds, which should be from a height of 2 ins., the colored spots will blend with the white mass, forming beautiful veins and flecks. If holes are desired, rods of wood, dipped in melted paraffin, are placed in the molds.

This composition is especially good for electrical switchboards. Clock-cases, table-tops and statuary can also be made from it. Fine sand, or even sawdust, may be substituted for marble-dust. For each pint of dampened saw-dust, it will be necessary to use a pound of magnesite.—A. H. WAYCHOFF.

Convenient Stairway

IN a new house having three rooms and hall on the lower floor one compact stairway serves the purpose of two. A hinged door at the bottom of the kitchen branch and a sliding door at the front hall face of the small landing give privacy to either section of the stairway. Warm air is prevented from rising when bedrooms upstairs are being aired. Also the noises downstairs do not disturb anyone who may be asleep or ill upstairs. Another feature is the hinging of the second step from the bottom of the kitchen branch making, beneath it and the third step, a storage space for cooking utensils and dish-drainer, since there is no pantry. This arrangement is a great space-saver.



Much valuable space can be saved by this kind of stairway

The Ideal Home for $5,000

By Geo. M. Petersen

THE ideal home which we will describe this month, is a building in which everything was studied out in advance; in which every dollar was reckoned before the job was started and one which, through attention to details of small things, was kept down to a very reasonable figure. The house is modern in every respect, has an attractive exterior and a pleasant interior and is altogether a very desirable home for the person of average means.

The completed five-thousand-dollar home. Note the spacious closed veranda and the broad cornice

Many persons who are now living in rent are perfectly able to build a home of their own but dread to begin operations because they are afraid that the ultimate cost will far exceed the appropriation. This item of "extras" is, in the great majority of cases, one which causes a great deal of trouble between the owner and the contractor, but if the proper attention is paid to the little things before the contract is awarded there will be no chance for the extra expense.

The cost of the house under discussion was as follows:

Lumber, Millwork and Glazing.	$1541.00
Carpenter Labor	705.75
Mason Work, complete	1425.00
Plumbing	425.00
Heating, Hot Water System	400.00
Painting	275.00
Electrical Work	75.00
Decorations and Fixtures	150.25
Total Cost	$4997.00

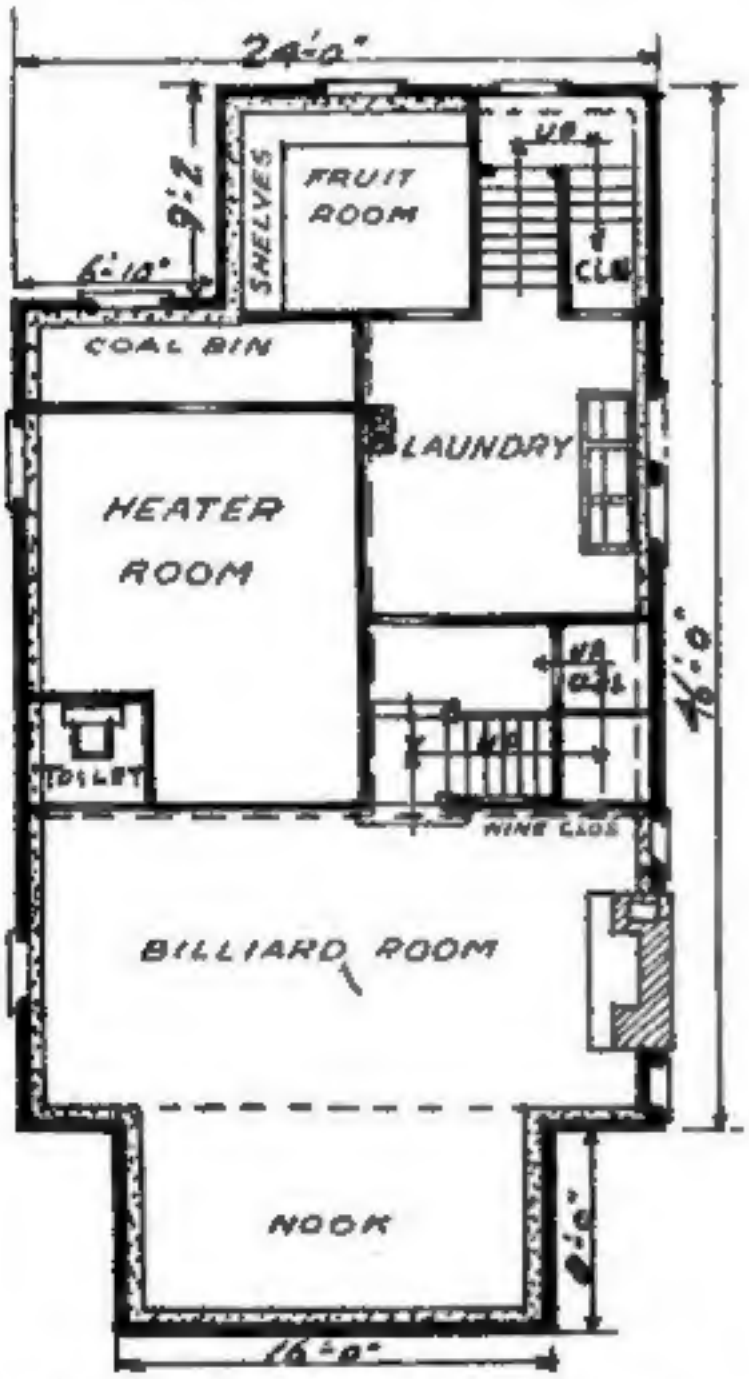
In the first place the plan was drawn and then studied until each room was ceduced to the minimum size which rould be used and still have it desirable; in this way three feet were saved in the length and two feet in the width of the house. The next step was to figure the framing of the house so as to reduce everything to stock lengths and sizes in order to avoid waste of material and the cost of labor for cutting. Following this the interior finish was gone over very carefully and everything which would not actually add to the value of the premises was eliminated, the finish of the various rooms was gone over thoroughly and another floor plan made for future additions and equipment. The electrical work was then taken up and only such outlets as were actually necessary were provided; the plumbing and heating were also gone over very thoroughly as was the painting. The exterior also received its share of thoughtful attention with the result that not only was a nice sum saved on this item but the appearance of the house was actually improved.

We will now investigate the house floor by floor and see what was finally accomplished.

A Basement Complete in Every Detail

In the basement we have a billiard room eleven feet wide and twenty-two feet long, which has a nook fourteen feet wide and seven feet deep, in which may be placed a card table and some easy chairs for the onlookers. The floor of these rooms is of No. 2 common yellow pine, seven-eighths of an inch thick laid over 2 by 4 No. 2 hemlock sleepers which are laid on top of the concrete cellar floor. The tongues of the boards in this floor were painted with white lead and oil before they were

driven together and the sleepers were covered with a waterproof building paper before the floor was laid. The reason for these steps was to protect the room from dampness. The waterproof paper protected the under side of the flooring and the paint in the joints protected the room from any dampness which might have entered through the floor. The floor was then stained to imitate oak and given a coat of shellac and



Plan showing dimensions and arrangement of rooms in the basement

another of good floor varnish. The walls and ceiling of these rooms are plastered with one coat of patent wall plaster applied directly to the stone on the exposed walls and on lath on the inside wall and ceiling. The fireplace at the end of the room was built of selected common brick and provided with a rough hemlock plank for a shelf. The stairway to the first floor hall was built of yellow pine and provided with a stock handrail and 1¾ by 1¾ spindles, all stained to match the floor.

At the left of the billiard room a small toilet is provided with a vent out under the steps leading to the front door. Back of this toilet is the heater room where the hot water heater was installed. The coal bin was located immediately in the rear of the heater room. To the right of the heater room we find the laundry with a three-part cement laundry-tray and in the rear projection we have a fruit room with a sand floor, on which the sand is three feet deep to allow for vegetables being planted during the winter months, to prevent them from decaying during the winter months. A small closet is provided under the rear stairs in which are kept the wash boiler, pails and other rough household utensils. A small wine closet is also provided under the stairs to the billiard room, and another closet is built between the billiard room and the laundry. The partition around the stairs is plastered the same as the billiard room and all plaster was painted a light tan to harmonize with the oak floor and woodwork.

An Attractive Entrance Hall

Entering the house from the front entrance we come into a vestibule, which is provided with a tile floor and birch trim, stained mahogany, and then into the main hall. This hall is finished throughout in plain cut red oak, with the exception of the front stairs which are birch and white wood finished with mahogany treads and white enamel risers. The doors leading from this hall to the living room on the right hand, and the dining room on the left hand, are glazed French doors which open into the rooms. The living room is finished in North Carolina pine, polished with a forest-green stain which makes a very pleasing and restful finish. The entrance from the veranda to the living room is through two pairs of French doors located as shown on the first floor plan. The dining room is also finished in North Carolina pine, polished with a rosewood oil stain which makes a very attractive and rich-appearing finish. The dining room is also provided with a window seat in the bay window. A china closet is afforded at either end of the seat. The radiator for the room is placed under it. The dining room is not finished with any paneling or

ceiling-beams but only with a ten-inch high base and a chair rail.

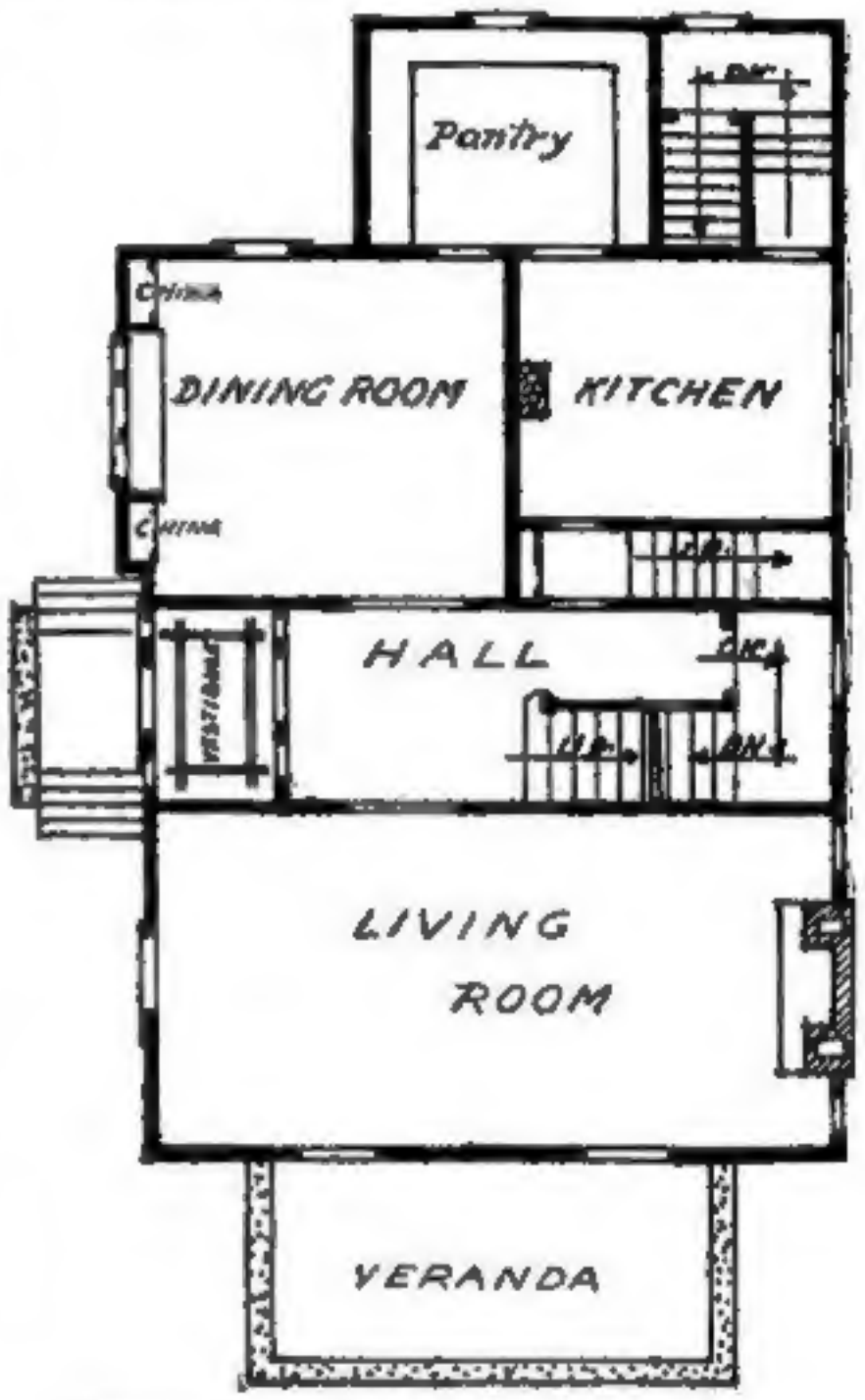
The kitchen and pantry are done in natural-finished yellow pine and the pantry is equipped with cupboards on two sides and a counter across the end. These cupboards are provided with sash doors, drawers, tilting flour-bin, cutting-boards, tin closets, etc., which are very essential to the workings of the culinary department. The only connection between the kitchen and the dining-room is through the pantry, so that there is a double door between the kitchen odors and the dining table. The rear stairs go up to the landing between the first and second floors, where they join the main stairs to the second floor.

All floors throughout the first floor with the exception of the vestibule, kitchen and pantry and rear entrance hall, are of ⅜-in. "select" oak. The kitchen and pantry floors are of ⅜-in. yellow pine and the vestibule floor is of tile. All the wood floors are stained a medium dark oak and then shellaced and varnished.

Economy of Space Observed

On the second floor we find a hall, four bedrooms, bathroom and a rear veranda. The bathroom is finished in white enamel with a tile floor and hard plaster wainscot marked off to imitate tile. This wainscot is also white enameled. There is a small linen closet opening off the bathroom and a medicine case built in the partition over the lavatory. The balance of the woodwork on the second floor is white enameled on white wood with the exception of the doors which are of unselected birch, stained mahogany. All the upstairs floors are of "select" oak ⅜-in. thick and finished with a light stain, shellac and varnish. All closets are provided with shelves and hook strips and the mantel is provided with a built-up pine shelf as is the one in the living room. The attic stairs lead up over the rear stairs and are off the main hall. The rear porch is covered with canvas and is accessible from either of the rear bedrooms.

As will be noted from the picture, the exterior of the house is sided half way up and shingled the upper half. The siding is painted a light lead color while the shingles are a deep brown, the trim being white. The ceiling of the veranda as well as the plancier of the main and dormer cornices is plastered with stucco on wood lath and makes a very pleasing effect. The appearance of the house is also greatly improved by the small lights in the upper sash of the



Arrangement of rooms on the first floor. Note the large living room

windows and the dormer windows, which are broken out of the roof on the front and two sides. The chimney extends up the outside of the house all the way and, while it adds to the cost of the building to run up an exposed chimney of this size, it also adds greatly to the looks. The shingles on the upper part of the building are laid in alternate courses of six inches and two inches, while the siding is laid three inches to the weather.

This makes up a house that is fit for anyone to live in and at a price within the reach of almost anyone in this day

when it is so easy to obtain money on first and second mortgages. There are other designs which may be built at the same price, or even less, and perhaps are more desirable than the one illustrated herewith, but this plan is used as an example of what can be done when economy is the rule of the day and the owner will consult with the planing millman, the mason contractor, the electrician, the painter, the plumber and the heating contractor instead of leaving everything to the architect, who in many cases, although fully able to draw beautiful pictures and artistic plans, is

The bedrooms on the second floor are all located conveniently near the bath

totally unfamiliar with building conditions at the time the house is to be erected and in all probabilities could not tell you what the sizes of stock materials are.

For instance, it is a common occurrence for architects to lay out a building which will call for a stud of such a length that perhaps a foot and a half will have to be cut from each one. Practically all lumber, both dimension and boards, come in even feet such as 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, with a different price on nearly every length so that a plan calling for an 18-ft. 6-in. stud for instance, would require the owner to pay the long price for a 20-ft. stud and then pay a carpenter 50 cents to 70 cents an hour to cut it down to size. The most economical sizes to use are from 12 to 16 ft.

Useless Expense Should be Avoided

Also in the matter of electric light outlets and plumbing the owner can generally save money by consulting the man who will do the actual work unless he is positive that he has an architect who is perfectly capable of cutting out all the surplus expense without spoiling the effect of the finished house. Now the builder is being run by the architect who wants to try out some theory at someone else's expense. He incorporates this theory and that idea into the builder's plan, tells the builder that the house can be put up for so much money and collects his fee. Along comes Mr. Millman to put in his figure for the lumber and millwork. He sees this, that and the other thing in the specifications and a plan with a lot of knick-knacks on it and immediately shoots his price up to cover items that are indefinite or questionable. It is not up to him to make suggestions to the owner or he will get in bad with the architect, and the owner is liable to get provoked because he has not asked for any advice. The owner becomes discouraged and drops the matter until a friend whispers in his ear. He digs up the old plan, calls on Mr. Millman and asks where the expense could be cut. He is shown a few items which will reduce the cost several hundred dollars and with a new courage, he goes after the other contractors until he is surprised to find that he has not only kept the cost below his estimate, but has, in many cases, greatly improved the arrangement and appearance of his house. The opinion and advice of the man who is to do the work is far more desirable than that of some cub architect.